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CONTENTS.

(VOL. III, No. 1.)

LIST OF ILLUSTRATIONS.

ORIGINAL ARTICLES.

THE QUESTION OF A BANANA INDUSTRY IN BRITISH GUIANA.

BY

C. W. WARDLAW, Ph.D., D.Sc., F.R.S.E.

Banana Pathologist, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

INTRODUCTION.

At least three official reports are concerned with the possibility of establishing a banana industry in British Guiana. The first of these (1895) was inconclusive. [1] The second report of a commission with (Sir) J. B. Harrison as Chairman 1910 [2] considered the proposition in a detailed manner and in the light of Suriname experience. The conclusion reached was that the establishment of a successful banana industry in British Guiana either at that time or in the future was highly improbable. The matter was again taken up in 1926 [3] when the difficulties to be overcome in inaugurating an export trade of bananas were discussed under several heads. It was considered that it would be a great benefit to the colony if such an industry could be conducted on peasant proprietor lines, and that such an industry, successfully established, would exercise considerable influence in attracting colonists from the Islands and elsewhere. At the present time the possibility of establishing a banana industry is still being considered by some British Guiana agriculturists. The detailed examination of such a project is, of course, a matter for local experts, but some general considerations, based on a broad examination of the Industry as a whole, may not be inopportune at this time.

REQUIREMENTS OF THE BANANA INDUSTRY.

At the present time only two bananas are of any real importance in the banana market. These are (1) the Canary or Dwarf banana, and (2) the Gros Michel or Jamaica banana. The former is grown extensively in the Canary Islands and carefully crated and speedily placed on the English Market. The plant is very hardy and produces some fruit even on poor soils. The fruit unfortunately

(1) Reports of Special Commission on Proposed Banana Industry and on Minor Industries British Guiana 1895.

(2) Report of the Commission appointed to consider the question of the cultivation of bananas in the Colony and the possibility of establishing export trade in the product. Combined Court, No. 585 British Guiana 1910.

(3) The possibility of Developing a Local or Export Fruit Trade. British Guiana Combined Court No. 39, 1926.

does not stand up to long-distance transport and until much more is known of its cool storage and carriage requirements it is not likely to become the basis of a banana industry in the Caribbean area. Of paramount importance both on the English and American market is the Gros Michel banana grown extensively in Jamaica, Central America and Columbia. For large scale enterprise the fruit has everything in its favour, size, symmetry of bunch, and good packing, carrying and ripening qualities. Its one disadvantage lies in its susceptibility to Panama Disease—a disease which has caused great losses in Jamaica, Central America and Suriname. Many efforts have been made to find a substitute for the Gros Michel, but among the several varieties immune to Panama Disease none has the combination of advantageous commercial qualities of the Gros Michel. Experimental shipments with other varieties have proved disappointing—the Lacatan seems to be the only immune variety about which optimism may be entertained. The Fruit Company have approximately 4,000 acres of this variety in Panama and at present experiments are being conducted with a view to determining the precise set of conditions favourable to transport and subsequent ripening to an attractive yellow colour.

As matters stand at present, then, any banana project in the Caribbean region must still begin with a consideration of the possibility of large scale production of the Gros Michel banana.

LARGE SCALE OPERATIONS IN CENTRAL AMERICA AND JAMAICA.

Compared with many other varieties of banana, the Gros Michel is exacting in its soil requirements. It must have, for maximum production and continuous cropping, a deep, rich, well drained, moisture-holding sandy loam. Such conditions are found on the good properties in Jamaica where assiduous husbandry (with cheap labour) is the rule.

Under the modern system of extensive banana production in Central America and Columbia the plantation as a rule receives no detailed cultivation. An area of virgin forest land is surveyed and the underbush cutlassed sufficiently to permit of the laying out of rows, the position of each stool being marked by a stake. Suckers or "bits" are next planted in holes 15 inches wide and deep. The tall forest trees are then felled, and after some time the young banana plants begin to appear through the mass of trunks, branches, and twigs. As both the growth of the plants and decay of the forest debris take place quickly, in a short time, with periodic cutlassing of the secondary bush an orderly plantation is established. Apart from a varying amount of attention to drains, upkeep of roads, cutlassing of bush, trimming of stools and collecting of fruit the plantations receive no other attention. When soil deterioration and the incidence of disease reduce the crop to a certain point the plantation is abandoned and new land is opened up.

As the result of much experience the Central American plantations are now mainly confined to the deep alluvial soils where good drainage can be effected, and as a rule some kind of soil survey is conducted in order to assess the suitabi-

lity of the land and its probable period of production. Roughly speaking the soils which have been used for banana cultivation in the past 30 years or so may, from the point of view of fertility relative to the Gros Michel, be divided into three classes; [1] Poor soils on which the production of the Gros Michel very obviously falls off after 4 to 7 years; (2) intermediate soils, probably with some initial defect such as compactness, sourness, high water-table, or insufficient aeration, whose deterioration after 10 to 14 years leads to abandonment; (3) very good soils which have been cropped continuously for 20 or more years and which are still in a first-rate state of productiveness. In short, in Jamaica, Central America and Colombia there are very considerable tracts of good land, in favourable situations, which, either with detailed agricultural treatment, or with none at all, show exceptional suitability to the rather exacting requirements of the Gros Michel. The constant supply of bananas required to meet the demands of the English and American markets is dependent, then, not on indifferent soils of fluctuating and irregular production, but on those large areas of good soils where a high degree of acquired or natural fertility is the rule.

The Banana Industry in Suriname.

In considering the possibility of a banana industry in British Guiana it is instructive to dwell on the history of the Suriname industry where very comparable soil and growth conditions obtain. The banana industry in Suriname was a direct result of the failure of the Cacao industry on account of Witch-broom disease. In seeking for an alternative crop to replace cacao it was decided in 1906 to establish a banana industry on plantation lines. The contract between the United Fruit Company and the Government of Suriname provided among other things that 2,470 acres of bananas should be planted each year for 3 successive years, with a view to producing 1½ million bunches of fruit per annum. The minimum shipment contracted for was 20,000 stems per week.

The actual production of Gros Michel bananas during the brief life of the Suriname Industry was as follows:

Year	9-hand	8-hand	7-hand	Total	% Count bunches
1908	113,008	70,995	35,660	219,663	83
1909	381,178	176,001	91,475	648,636	86
1910	293,689	205,699	152,705	652,019	80.4
1911	172,250	118,457	93,390	384,097	79.8
1912-13	33,711	69,371	108,633	211,715	...

The actual annual production never touched the contracted figure, and few ships ever carried their contracted minimum cargo of 20,000 bunches. Production had, of course, been calculated according to Central American standards but, owing to

(1) C.W. Wardlaw Virgin Soil Deterioration. The Deterioration of Virgin Soils in the Caribbean Banana Lands. Trop. Agric., VI, No. 9, 1929.

the nature of the soil and to the incidence of disease, in actual practice it only amounted to about 40 per cent. of the estimated figure. Disease appeared first in 1906, seriously in 1908 and by the end of 1910 twelve hundred hectares of a total of 3,300 h. a. were infected. It was at first thought that the disease had been introduced from Jamaica with the planting material secured from that source but later it was ascertained that the disease had been present in the colony before on the susceptible apple banana. The spread of the disease was at first slow, but later it became rapid and led to the complete failure of the industry in 1912. Immune varieties such as the Congo and Bumulan were tried out, but these have not proved acceptable to the trade.

Production in Suriname was organised on the plantation system. Contracts with the planters were of two kinds, a contract with those who received advances and loans and a contract with those who did not. Full details of financial arrangements are set out in the 1910 report already quoted and need not be repeated here. Cultivation was carried on almost entirely on the large river estates on the Suriname and Commewijne rivers Most of the land consisted of old laid-out plantations which had been abandoned after prolonged sugar cultivation, or which had recently supported poor stands of coffee and cacao. Some of the areas consisted of virgin soil. Most of the soils were of stiff heavy clay with occasional areas of more friable sandy loam. On some estates pegassey soils were used for banana growing. To quote from the 1910 report "It was particularly evident that the more loamy and friable the nature of the soil the easier it is of cultivation and the more vigorous is the growth of the bananas, and that the heavier, more tenacious soils produce less healthy growth of the plants and fewer and smaller bunches of bananas."

Cultivation of the banana in Suriname proved to be a much more arduous and costly business than in Central America. The ground had to be cleared, the vegetation burnt and the land forked before planting, while the weed flora had to be cleared five or six times during the first year. Thereafter the land was forked once per annum with four to five clearings. In Central America on the other hand the preliminary work is of the simplest nature (as described above) while, owing to the rapid and vigorous growth of the bananas, brushing is required only once or twice a year, while forking is never carried out. Thus in Suriname plantation upkeep was much more expensive than in Central America, while production was very much less—observations that merit careful attention where a large-scale industry is being contemplated. In short experience has definitely shown that Suriname has no natural banana lands comparable with those of Jamaica or Central America.

SUITABILITY OF BRITISH GUIANA SOILS FOR BANANA GROWING.

The suitability of soils to crops is a subject on which one cannot be dogmatic, and with regard to British Guiana soils in particular, it would, in some cases, be difficult to arrive at conclusions were it not

for useful information available from Suriname. The rich alluvial clay soils of the British Guiana coast lands, while of marked potential fertility, as borne out by long continued production of sugar cane and rice, are not highly suited to the rather exacting requirements of the Gros Michel banana. On account of the high percentage of clay, the coastal soils are so compact as to make extensive root development of the Gros Michel mechanically difficult, while the usual tillage 9-12 inches deep by no means satisfies the root requirements of a productive stool. A brief explanation will make this clear. In good soils in Jamaica and Central America the sucker is planted in a 15-inch hole, and the root system, which develops freely in sufficiently open, well ærated soil, grows downwards till the water table, some 2½ to 3 feet from the surface, is reached. In contrast to the vertical root system a horizontal root system is a sign of unfavourable soil conditions. The feeding range of the horizontal root system is obviously a limited one, so that the speedy exploitation of the shallow surface soil soon leads to the growth of plants of diminished stature and lowered production. It will readily be apprehended that the stiff clays of the coastal belt, with only 9-12 inches of open ærated top soil may give good plants and fruit for one or perhaps two years, but thereafter a serious decline in productiveness is inevitable. Some interesting observations on this subject were made by the writer on a plot of Cayenne and Congo bananas at the Experiment Station, Georgetown. The Cayenne bananas, planted on stiff clay soil in October 1927 gave fruit in October 1928 ; the plants grew well, attained a stature of 12-13 feet (from soil level to emergence of young leaves) had stout trunks and well developed broad leaves ; all the plants, 40 in number, bore fruit, 7 and 8-hand bunches being the rule. The first record therefore was one of promise. This however was not borne out by the subsequent crops. Many plants did not fruit a second time, while those observed by the writer in September 1929 were of small stature, 7-8 feet only, with puny trunks and thin leaves. Only a few of the plants carried fruit, the bunches being small. A soil section dug through a stool showed that, on account of the compactness of the soil, the suckers were only some 10 inches deep. In the same bed Congo bananas, planted in October 1927, had a stature of 8 feet, and were carrying small bunches of fruit, mostly 5-hands, the largest count being 7-hands. Again this compared unfavourably with the first year, when large vigorous plants carrying 8 and 9-hand bunches were the rule. Thus, even in a relatively hardy variety such as the Congo we have a reduction from 9-hand to 7-hand and 5-hand bunches. Such a decline in productiveness is fatal to an established industry where steady output is of fundamental importance. Unless a very thorough form of deep cultivation could be employed (which would take several years to achieve) these clay soils are very uncertain for the Gros Michel by reason of the fact that the good initial production of fruit would, under existing conditions, quickly change to a disappointing, irregular, and diminished output. From the point of view of disease the experience with the similar Surinam clay soils should be taken as a serious warning ;

indeed it would appear that Panama Disease on the Suriname clays was perhaps more destructive than in any Caribbean area. Even if Panama Disease has not been reported in British Guiana the probability of its early appearance in large planted areas is unfortunately very great, and so far there is no known means of preventing or curing the disease.

The sand reefs which occur here and there in the coastal alluvial belt have hitherto been regarded as practically useless for economic purposes. On this subject the writer might contribute the observation that in Surinam he observed very good Gros Michel plants growing on the narrow belt of good friable open soil where clay and sand are intermingled. Such areas are, of course, insignificant, passing quickly on one side into poor sandy soil and on the other into stiff clay. They are mentioned here because they are indicative of the requirements of the Gros Michel for full development.

The pegassey soils aback of the coastal alluvium present a series of new problems in banana cultivation and disease. Where only a shallow layer of pegasse overlies clay the general history of a plantation will probably be much the same as on a clay soil, after the initial influence of the superficial pegaase has disappeared. Where the pegasse layer is somewhat deeper, says from 1 -2-3 feet we have at present little guidance, as no large scale banana cultivation has been carried out continuously over a number of years on this type of land. In Suriname on the plantation Accaribo good yields were obtained from such land for two or three years, after which the plantations were affected by Panama Disease to the point of abandonment. From what the writer was able to observe of banana (Cayenne) and plantain cultivation on these lands in British Guiana the general impression formed was that the good fruit obtained during the first year or two would quickly be succeeded by a rapidly declining production. On examining root systems it was found that these were inextensive and showed a very considerable amount of disease. Where this occurs there is a strong probability that individual stools would show that falling-off in growth and productiveness characteristic of unfavourable soil conditions. On these soils, then, the question is whether or not the initial productiveness will be maintained. Experimental records collected over a number of years—the only sound basis for a commercial enterprise—are unfortunately not available; in view further of the virulence of Panama Disease on such soils (as in Suriname) it would be unwise to embark on any extensive planting scheme.

As distinct from the pegassey soils (where the underlying clay is involved to some extent in cultural operations) the deep virgin pegasse soils such as those of the N.W. District may be briefly considered. So far as the writer is aware no extensive or continuous cultivation of bananas has been attempted on such land and again it would be desirable to have experimental evidence before encouraging extensive planting. Of the other soils in this district the sand hills, of residual quartz sand, may be ruled out, while the rolling hilly formation

covered by red-brown lateritic soil must also be discounted for banana growing. Similar hillside areas were frequently planted in Central America but a speedy abandonment was the rule.

The river alluvial soils, of silt, clay, or arenaceous clay do not appear to have been examined in any great detail in this colony, but general observations do not lead one to suppose that there are extensive areas where marked fertility is the rule. Observations made on the alluvial soils of the Demerara river did not reveal any considerable areas of land suitable for continuous banana cultivation. One flat area of river-side alluvium—a greyish white arenaceous clay—at Mackenzie, had been taken out of bush and planted with plantains and bananas. The insignificant stature of the plants at the end of 12 months was indicative of unfavourable growth conditions.

In concluding this section it should be observed that, in the days of the Suriname industry, plantations were treated more or less along the same lines as in Central America. We are now in a position to recognize, however, that the empoldered clay soils, pegassey soils and virgin pegasse of British Guiana are in many ways unique and do not necessarily lend themselves to the agricultural practices of adjacent Caribbean areas. The special local conditions and their relation to soil fertility and production of crops cannot be understood by analogy alone. Gaps in our knowledge can only be filled by local experimentation, and until this has been satisfactorily carried out it would be taking a considerable risk to embark on any large scale enterprise.

CONCLUDING OBSERVATIONS.

In Suriname it was proved, by a costly experiment, that there were no extensive areas of soil highly suited to the exacting requirements of the Gros Michel banana. The latter is still the only banana acceptable in large quantities to the European markets (i.e., leaving aside the Canary Banana industry where a short carriage and crating are pre-requisites). Conditions in British Guiana are very similar to those in Suriname, and when the possibility of a banana industry is being considered it should be borne in mind that the soils of British Guiana on which cultivation might be attempted (i.e. the coastal clay and pegassey soils) are very similar to those which in Suriname had to be abandoned after 3 or 4 years on account of Panama Disease. So far Panama Disease has not been reported in the Colony, but as a supply of Gros Michel suckers would have to be introduced, sooner or later the Disease would inevitably appear. Optimists who might count on the probable absence of disease would have to contend with the rapid decline in productiveness after two or three years as already described. There is no doubt that satisfactory bunches of fruit can be produced in the Colony. To create an industry, however, a certain minimum production, say 20,000 stems per week, is required. This production must be absolutely regular and continuous. To produce even this quantity requires a very considerable amount of organisation and necessitates operations over an extensive acreage. Facilities for the collecting

of harvested fruit and for its transport to the quayside must be such as to ensure its being loaded with the utmost despatch—a factor vitally important to the general well-being of the fruit in transport. In Suriname, where the industry was organised on estate lines, it was only occasionally found possible to send off ships with their minimum contracted cargo. The difficulties in handling a corresponding industry not on estate lines but among small farmers would be very considerable indeed. In the contract between the United Fruit Company and the Suriname Government the planters were given 36 hours' notice in which to cut and deliver their fruit to the banana steamer. This is the usual type of expeditious handling of fruit required by the banana industry where transport is second in importance only to actual production.

Here one might quote to advantage a British Guiana publication of 1909. [1] "Co-operation is essential for a successful banana industry. It would be necessary that all the bananas be delivered at the port of shipment within the 12 hours immediately before the ships are scheduled to sail, and the previous 24 hours would be given for cutting, packing, and transporting to the port. A very efficient organisation is required to accomplish all this work within such a limited space of time, aud unless everything works smoothly, considerable loss of fruit will result. In fact the banana industry is now run on such modern business methods that it would be necessary for a considerable area of bananas to be planted in the same district under a single Association, in order that management expenses may be reduced, and in order that transport and shipment could be economically carried out."

In short to create a banana industry it is essential to have consistent and continuous production of high-class fruit of the kind accepted by present markets, a uniform organisation and control over the whole industry, and an efficient transport system. Through the choice of unsuitable land, and the incidence of disease, production may fall below the minimum required to secure shipping contracts. In the absence of a good central organisation and suitable transport facilities, fruit may be cut too soon or too late for despatch or too full for satisfactory carriage, so that the planter may suffer by having fruit rejected and left on the quay. Under existing external and local conditions there can be little doubt that the establishment of a banana industry in British Guiana would be a very uncertain and difficult undertaking.

Since a banana industry is not likely to bring prosperity to the colony, it now remains to consider what can be offered in the way of constructive suggestions. Here it may be stated that, having recovered from the failure of bananas, the progressive Suriname planter is now on his way to prosperity. Experience has shown that the stiff clay and pegassey soils alike, which were of limited use for banana growing, have proved highly suitable for the cultivation of Liberian coffee.

(1) Stockdale, F.A. "The Question of a Banana Industry." Journ. Board of Agric. B. G. Vol. III, 1909.

Where bananas were decimated by disease, Liberian coffee is now flourishing in well kept orderly plantations. Young plants come into bearing in the third year and crop well in the fifth. By using bananas as a shade to the young plants, the planter in British Guiana would be in a position to place a considerable number of bananas on the market for local consumption and at the same time would establish on his land a hardy and remunerative crop highly suited to present labour conditions.

ADDENDUM BY THE DIRECTOR OF AGRICULTURE.

The banana question was fully discussed with Dr. Wardlaw during my recent visit to Trinidad and he suggested that it would serve a useful purpose if an addendum was contributed to his article elaborating any points on which information was not available at the time of his visit to this Colony.

In the first place, the fungus causing Panama Disease (*Fusarium cubense*) has been definitely isolated from wilted plantains both by Dr. Wardlaw and the present Government Botanist, Mr. E. B. Martyn. So far, it has been found to exist, along with and in the same plants as certain bacterial organisms hitherto considered as being the cause of the wilt disease, of fairly common occurrence locally, in plantains and certain varieties of bananas. The fact that *Fusarium cubense* does exist in the Colony is a serious matter for those who contemplate the extensive planting of Gros Michel (Jamaica banana) for export, bearing in mind the failure of the industry in Surinam, which has been ascribed to the rapid spread of this disease under soil conditions unfavourable to commercial production of the true Gros Michel banana. This variety fulfils all requirements of the trade, including the necessary ability to travel well. Compact in form, the bunch also develops an attractive yellow colour on ripening while the fingers do not fall readily from the strong central stalk when hung in a grocer's store. It must be recognised that no variety has yet been found to equal it in these essential respects and for that reason research work is being carried out with the object of securing a variety of this type which is immune or highly resistant to Panama Disease. This work is now in progress at the Imperial College of Tropical Agriculture, where a well equipped cold storage plant allows the various commercial qualities of new varieties to be carefully tested It should be stated that the Dwarf or Canary banana which grows so readily in the Colony, although not subject to Panama Disease, does not possess the commercial qualities mentioned above and is successfully and profitably handled only where produced near a consuming market.

The name Cayenne, as explained, is applied locally not to a particular variety but to two or three types not readily distinguishable, including the Gros Michel.

I encountered this difficulty soon after arriving in the Colony, hence work is in progress at the Georgetown Station in an endeavour to clear up satisfactorily this variety question and secure enough planting material of pure Gros Michel to carry out suitable large scale experiments and for distribution.

Indeed, considerable progress experimentally has been made already at the North West Station, where a ten acre block of pegassey land being brought under coffee cultivation was first established in bananas. This land had been under rubber (Hevea) cultivation and may therefore be regarded as of average fertility. Before any planting of bananas took place the drainage system was completely reformed and rendered efficient, the treatment being, if anything, better than that given by the average farmer. A careful record is kept of every bunch of bananas and complete data are so far available in respect to 747 bunches, made up as follows:—

No. of bunches.		*No. of hands each.*
1	...	12
1	...	11
13	...	10
54	...	9
120	..	8
256	..	7
221	...	6
71	...	5
10	...	4
747		

the average weight per bunch being only 35.6 lb.

It will be seen that the number of bunches of nine hands and over amounts to 69. If the eight hand bunch is considered a count bunch—as a rule nine hands and over fall into this category—the count bunches out of a total of 747 would be 189 in number, or roughly 25 per cent; while 64 per cent. is made up ofsix and seven hand bunches. From good banana lands the reverse would be obtained. In other words, these results although not conclusive tend to substantiate Dr. Wardlaw's views and are in agreement with the opinions hitherto expressed that British Guiana is hardly a country which lends itself to commercial banana enterprise. Unfortunately too, the economics of the industry are such as to preclude essential expenditure for transport and general organisation being undertaken unless large scale developments were likely to follow.

The Department, therefore, while fully appreciative of the efforts made in certain quarters to stimulate interest in a local banana industry, is in duty bound to state the facts as known for the benefit of those interested.

J.S.D.

THE TANNIA BEETLE, *LIGYRUS EBENUS* DeG.

BY

L. D. CLEARE, Jr., F.I.S., F.E.S.
Government Entomologist, British Guiana.

INTRODUCTION

The Tannia Beetle, *Ligyrus ebenus* DeG., has been an important pest of Tannias (*Xanthosoma sp.)* in the North Western District of this Colony for many years where it is known as "the Cockle." The writer commenced investigations on this insect in July 1927 following an extensive outbreak which occurred in the previous months of the same year.

During 1927 preliminary breeding records were obtained from material secured during that year, while field observations were also made on the pest. Owing to the lateness of the season the investigations could not be carried further. In 1928 the insects did not occur in any appreciable numbers, and the information obtained during the previous year was not greatly supplemented. The District was visited, however, in September 1928, and certain information bearing on the pest was secured. In July 1929 the writer again visited the North Western District for the purpose of continuing investigations on the pest, but again the insect was not prevalent, although present in larger numbers than in the previous year.

It has not been possible, therefore, to complete the investigation on this insect up to the present, but certain information has been obtained during the past two years which would appear to be of sufficient importance to warrant its publication.

ECONOMIC HISTORY

Although the earliest records relating to the damage of tannias by this beetle in the possession of the Department of Agriculture date only from 1923, there can be no doubt that the insect has been an important pest of this crop in the District for many years prior to that time.

From inquires, made in the District by the writer it would appear that there was an extensive outbreak of this beetle about the year 1900, when it is stated that, in addition to tannias, Indian corn (maize), plantains, and sugar-cane were attacked. Between 1907 and 1909 there appears to have been another outbreak of the insect, and on this occassion also the insects are said to have bored into the stems of plantains. In 1918 the insect is stated to have appeared again and in that outbreak serious damage was inflicted, amounting to ruin to several farm-

ers. In 1927 still another outbreak occurred and resulted in the investigations now recorded. On this occassion tannias principally were attacked, but instances of attacks on Yams (*Dioscorea sp.*) were met with also.

Economic Importance

As a pest of tannias *Ligyrus ebenus* DeG. is of the first importance, and indeed at the present time is the only serious pest of this crop in the North Western District.

In view of the importance of the tannia crop in connection with the establishment of coffee cultivation in that District any pest which seriously affects this crop must assume considerable significance. That the insect concerned has assumed this position there can be no doubt, but there can be no doubt also that there are occasions when too much is made of this aspect of the subject, and much loss is attributed to the ravages of insect when in reality only little has occurred. The whole "cookle" situation in the North Western District is complicated by economic conditions, and there is a general tendency to overstate the position, as far as the damage caused by the insect in concerned, in years when it is convenient to do so. These points are made here not with the object of minimizing the damage caused by the insect, but for the purpose of pointing out the danger of accepting rumours with regard to the loss which has been, or is being inflicted by the pest.

Ligyrus ebenus DeG. has been recorded also as attacking sugar-cane, but is of little importance as a pest of that crop. It must not be confused with other beetles not unlike it in general appearance such as *Dyscinetus geminatus* F. and *Dyscinetus bidentatus* Burm., known popularly as the Large and Small Hardback Beetles respectively, both of which are well known pests of sugar-cane, and at times inflict serious damage to that crop.

Habits

The habit of this beetle of breeding in pegassey soils, which are rich in humus and decaying vegetable matter, makes the conditions on most of the grants in the North Western District ideal for their propagation. The larvae feed normally on soil rich in humus and decaying organic matter and on the rootlets of succulent plants. The adult beetles also are strongly attracted to humus and decaying organic matter, the female beetles depositing their eggs in such substances. The damage caused by both larvae and adults to root-crops must be looked upon as but an extension of these habits, brought about by the agency of man himself.

The occasional finding of the insects by farmers in the swampy lands adjoining their cultivations has led to the belief in the District that these insects breed entirely in the swamp, and at certain times of the year leave these areas and descend upon the cultivations. In support of this, one is told that they can be

heard approaching, the low hum set up by their flight, being plainly audible it is stated, and on occasions it is even likened to the sound of distant thunder. For this reason the farmers are of the opinion that nothing can be done to rid their cultivations of the pest until the large areas of swampy lands in proximity are reclaimed.

The conditions which regularly obtain on the grants are such as to be entirely suitable to the breeding of the insect on the spot, which is in fact what has been observed to take place, and it is doubtful whether any serious infestation of grants occurs from the surrounding swampy forest lands.

NATURE of INJURY

INJURY BY GRUBS

Although the Tannia Beetle has occurred in the North Western District for a number of years it is only within the past two years that its economic status has been investigated. The reports of its injury that are invariably received refer to the damage caused by the adult beetle, and comparatively little is heard of the larval stage or "white worms" as they are called by the farmers in the District, indeed by the majority of the farmers these two stages of the same insect are not even associated, although the fact that "white worms" are injurious to tannias is known to some of them.

The attacks of these "white worms," or more correctly "white grubs," occur usually about the months of March, April and May, and are caused by larvae which hatch during the previous year and reach maturity about this time. These larvae eat into the tannia tubers shortly before the crop is ready for reaping and may inflict serious injury in this way.

If early planting is carried out, the sets or "bottoms" may be injured by this same group of larvae prior to pupation. This habit of the larvæ of attacking early planted sets is in part, although not entirely, responsible for the practice in the District of delaying planting until about July. A more important reason, however, is the attacks which take place at a later date on the young plants by the adult beetles which subsequently emerge, and this phase will be dealt with later. Planting should normally take place within a couple of weeks of reaping the previous crop, which occurs in April and May, but if this was done the sets, or "bottoms" would be attacked by the larvae nearing maturity and would be destroyed.

That these "white grubs" which attack tannias are none other than the larval stage of the tannia beetle has now been definitely established. These white grubs are, however, liable to be confused with, and in fact in the District are not distinguished from, grubs of other beetles two of which are of common occurrence.

INJURY BY BEETLES

The injury caused by the adult beetle is considered among farmers to be more serious than that occasioned by the larvæ or grubs. Under the conditions at present obtaining in the District this is probably true, but it should be remembered in comparing the damage caused by these two stages of the insect that a system has been developed which in itself reduces attack by larvæ to a minimum through the postponement of the planting season for several weeks. In this way the larvae have an opportunity of attacking the tubers only when they are nearly or over mature, and the period of attack is thus reduced to a minimum. No similar system has been envolved to escape beetle injury.

The adult beetles attack this crop in two ways, namely (1) either by feeding directly on the sets and tubers, or, (2) by boring into the growing plants and shoots. In both these ways they inflict serious damage, although it is probably that by the latter method of attack that they cause the greater loss.

In their attacks on tubers and sets the adult beetles bore their way in from below ground, in the tubers entry occurring invariably only a few inches below the surface level, while in their attacks on the sets entry is almost always accomplished through the cut surface, which according to the method of planting is placed uppermost in the ground.

The attacks on growing shoots are affected either from above, the beetle working down and destroying the young growing bud, or from below, by the insect working its way upwards into the bud and destroying it. The former type of injury may be consiedred perhaps less frequent than the latter.

In their attacks upon plantains and maize the beetles have been described as entering from above also, but the writer has not personally observed such attacks.

LIFE HISTORY

GENERAL ACCOUNT

At the commencement of the rains between April and June the beetles (Plate I) become active and appear in numbers about that time in the North Western District. They then damage tannia and other plants in the manner previously described. They may at such times be seen occasionally at lights in houses, but this is not a general habit of the insect. By the end of July adult beetles are usually not to be observed in the fields. While a large number of beetles die at this period other burrows into the ground and continue their life below the surface, and in this position they will live for several months.

In October or Noveember egg-laying commences. The eggs (Plate II, Fig. 1.) are deposited a few inches below the surface of the ground wherever conditions of moisture are suitable. The eggs require from nine to fifteen days to hatch. When first hatched the larvæ or grubs measure 7.0 millimetres, or about ¼ inch, and are

PLATE I.

Photo] [*L. D Cleare, Jr*

THE TANNIA BEETLE, *LIGYRUS EBENUS* DE G. (X 4)

like the full grown larvae in general appearance. The larvae require about eleven weeks to reach maturity and when full grown measure about 48 millimetres or 1¾ inches. Full grown larvae (Plate II, Fig. 2) may be found from March to June in the North Western District. The pupal stage (Plate III, Fig. 1) is short, and has been found to be from nine to sixteen days, pupation occurring from March to July. The entire life cycle of the insect thus occupies about a year.

It will be apparent, therefore, that the insect spends practically the whole of its life below ground, egg, larval, and pupal stages being passed thus, while a large portion of the adult beetle's existence is also spent below the surface of the ground.

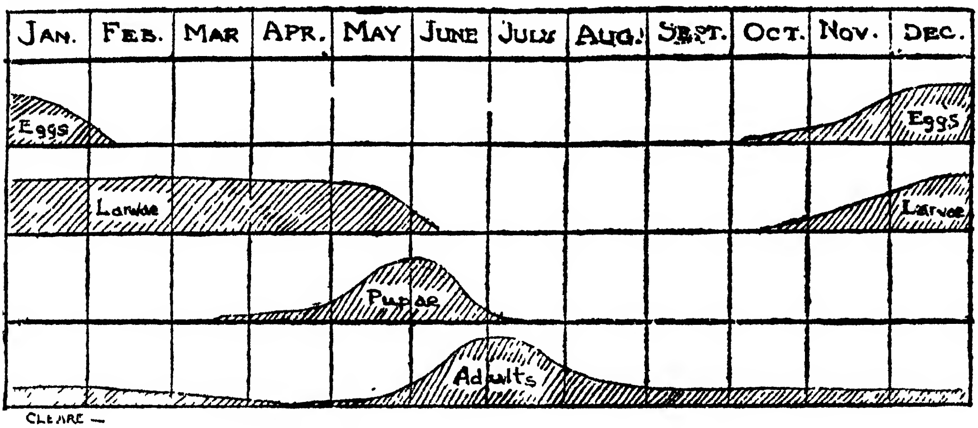

Fig. 1 —Diagramatic illustration of the periods of occurrence and of relative abundance of the different stages of the Tannia Beetle, *Ligyrus ebenus DeG.*

EGG

The egg is white in colour, the surface smooth, and when first laid is elliptical in shape both ends being evenly rounded. At the time of deposition the egg measures from 2.4 to 2.7 mm. in length and from 1.8 to 2.7 mm. in diameter (Plate II, Fig. 1) As development proceeds within the egg it gradually increases in size and by the time it is ready to hatch it is about half as large again as its original size and may measure from 3.1 to 3.8. mm long by 3.7 to 3.1 mm. broad. About two days before the egg is ready to hatch the young larva is visible as a coiled mass through the translucent egg shell, the head being clearly discernible. The egg requires from nine to fifteen days to hatch.

The hatching of the egg occurs by a splitting of the egg membrane on the dorsal surface of the larva. By a series of movements in which the body is bended and extended, the larva frees itself. The whole process is short, occupying about two or three minutes.

The eggs are deposited in the soil a few inches below the surface, and no special care appears to be exercised in doing so in a soil of suitable character. The beetles themselves are invariably found in soil of a certain degree of moisture and it is in such positions that the eggs are found. The pegasse soils of the North Western District offer all conditions suitable to the beetles themselves and

the subsequent development of the larvae, and in these soils the eggs are readily deposited. The eggs are deposited singly although several eggs may be found within a small area, and are not enclosed in a ball of soil. The number eggs deposited by a female has not been ascertained.

For the successful development of the eggs a certain minimum degree of moisture of the soil apparently is an essential. That eggs can tolerate a great amount of moisture was apparent in the rearing trials carried out in the laboratory, and eggs developed sucessfully on soils of a degree of wetness that would have been fatal to larvae of even large size.

LARVA

The newly emerged larva is waxy white in colour, the head being proportionately much larger than in the full grown larva. On emergence the head is also of a waxy white colour, but very soon begins to darken and in a short time assume a distinct yellow-brown colour. The body of the larva bears a number of hairs on the segments which also are yellow-brown in colour, the legs also being of this colour The freshly emerged larva measures about 7.0 mm. in length, and the width of the head capsule 2.4 mm.

The full grown larva (Plate II, Fig 2.) is a thick-bodied grub, the body of which is curved, and is a typical Scarabaeid larva in appearance. It is white in colour deepening at the posterier end to a dark grey almost black colour, due to the dark colour of the food contained in the viscera showing through the transparent cuticle; the head capsule is chestnut coloured and is coarsely punctate, the punctures being especially coarse and dense on the portion immediately above the clypeus, the mandibles being almost black; the legs are of a pale orange-yellow colour, and the spiracles light chestnut. The venter of the last abdominal segment bears a number of bristles the tips of which are distinctly hooked, and a well defined closely-set median double row of modified bristles, each having the appearance of a minute spine or denticle. The larva bears a number of hairs on the segments which are a pale chestnut colour The full grown larva measures approximately 46.0 mm. in length (1¾ inches) and the width of the head capsule is 7.6 mm.

Prior to each ecdysis the larva forms a cell and ceases feeding for a couple of days. If they are disturbed while in this stage larva usually succumbs.

PUPA

The pupa measures on the average about 22 mm. in length and about 13 mm. in breadth, and is a pale orange-brown in colour Its general form is well shown in (Plate III, Fig. 1.) The mandibles are well developed and roughly triangular in shape the apex truncate. The labrum is wide transversly, its median length being about one-fourth its width, the lower edge being almost straight. The maxilliary palpi are relatively stout, the apex bluntly pointed and projecting somewhat below the level of the other mouthparts. The elytra pads are smooth or only obscurely costate.

ADULT

The adult of *Ligyrus ebenus DeG* (Plate I.) is a rather stout jet-black beetle having an average length of 23 to 29 mm. in specimens obtained from the North Western District.

The head is roughly triangular in shape, its surface marked with numerous transverse undulate regulae which gradually reduce and are replaced by shallow punctures on the upper half,

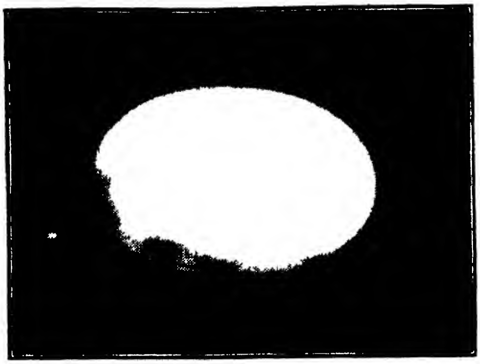

FIG. 1.—EGG OF *LIGYRUS EBENUS* DE G. (X 15)

Photos] [*L. D. Cleare, Jr.*

FIG. 2.—FULL GROWN LARVA OF *LIGYRUS EBENUS* DE G. (X 3)
Note blackened areas on upper and middle abdominal segment due to attack by the fungus *Metarrhizium*.

the occiput being smooth except for a few sparce shallow punctures. In front of the clypeal suture there are two distinct bluntly conical processes, the area caudad to these processes being distinctly intended. The clypeus has strongly oblique sides which are conspicuously margined and elevated, the apex of the clypeus being almost truncate, the apical margin about one-third the width of the base, distinctly reflexed, and interrupted in the middle by a concavity which separates two small processes, the so called "teeth." The mandibles are visible from above beyond the sides of the clypeus, equally bidentate and upturned at the apex.

The pronotum is distincly wider than long, and about twice the width of the head, the sides are broadly and evenly arcuate and are narrowed slightly both anteriorly and posteriorly, the antero-lateral angles sharply produced anteriorly, the postero-lateral ones broadly rounded, its surface is uniformly convex with numerous coarse shallow annular punctures which are somewhat sparcely distributed throughout but more crowded on the sides than in the middle. The anterior and lateral borders distinctly margined and the posterior plain and fully bisinuate. The anterior border bears a small median bluntly conical process caudad of which is a distinctly depressed area, the surface of which is marked with undulate regulae.

The scutellum is small but quite distinct, the surface smooth except for a few minute punctures,

The elytra are only slightly longer than their combined width, which is only slightly wider than the pronotum. Each is traversed longitudinally by a number of slightly impressed double rows of coarse circular punctures giving the elytra a somewhat striate appearance, anteriorly these punctures may be confluent. In addition to these double rows of punctures the surface of the elytra bears numerous closely set and irregularly distributed puuctures, similar to those forming the double rows, except in the marginal areas where they are much reduced in size and may be even minute Near the caudal margin of the elytra are two feebly conical-processes.

The forelegs are relatively stout and adapted for digging. The tibae bear three distinct tooth like projections on the hind mergin, stout and acute, the central being sometimes more developed.

Adults begin to emerge in April and may continue to do so till July. In the North Western District they are usually most abundant in May and June. It is probable that after emergence the adults may remain in the ground for a period until the commencement of the mid-year wet season when they appear in the fields. It is probable also that mating occurs about this time although there is no evidence to support this at present. After a short time in the fields the beetles enter the ground again where they remain for several months before egg-laying commences. Field observations as well as rearing in the laboratory both confirm this. In the laboratory a heavy mortality occurs amongst the beetle during this period, and field observations point to the same being true under natural conditions.

Methods of Collecting and Rearing

In order to study the life history of the insect a number of larvae and adults were collected in the North Western District and brought to the laboratory in Georgetown where investigations were continued.

The adults were confined in 12-inch standard size flower pots filled with fine coconut fibre and fibre-dust and covered with a cylindrical wire-screen top. The

pots were placed in earthenware dishes of 12 inches diameter and 3½ inches depth, and the dishes then filled with water to the depth of about 1½ inches. The fibre readily absorbed the water, and as the level of the water was reduced it was brought up again to the 1½ inch depth. In this way it was found that a constant degree of moisture was maintained in the pots, varying from saturation at the bottom to just dampness at the top, and thus the beetles were afforded an opportunity of selecting the layer with the most desirable degree of moisture. The beetles lived satisfactorily in this medium, and deposited eggs freely when the oviposition period arrived. It was soon noticeable that the beetles churned the fibre and compacted it into a more solid condition and descended to the bottom of the pots where the fibre was saturated and where after a few weeks it developed a fetid odour. While the beetles themselves remained in this layer, the eggs were always placed at a higher level where the moisture was considerably less, and between 5 and 6 inches below the top of the pots. In this medium the adults lived for many months feeding apparently on the fibre, but it was found that if tannia tubers were introduced that the beetles fed readily upon these. For a few days after the tannia tubers were placed in the pots they were untouched by the beetles, but as fermentation set in they were attacked readily and eventually destroyed completely.

After oviposition commenced the pots were searched regularly for eggs which were removed for rearing purposes. In this connection it was noticable that if the beetles were disturbed every day that egg laying was suspended, and was resumed only after a few days of non-disturbance.

Eggs obtained were placed at first in salve boxes either on damp coconut fibre or finely sifted soil, and while emergence took place satisfactorily this method was abandoned subsequently in favour of the glass method to be described later on account of the difficulty experienced in rearing the larvae in these boxes. After the salve boxes were abandoned the eggs were placed on wet coconut fibre in ordinary ½-pint drinking glasses. The fibre was well wetted, almost to saturation, usually about 2-inches depth of fibre being placed in each glass, and the eggs placed on this, a single egg to each glass, and the glasses covered with metal lids. In this manner the eggs developed satisfactorily and larvae subsequently emerged.

Another difficulty encountered was the appearance of predaceous mites and thread-worms (Nematodes) which sucked the eggs and so destroyed them. This occurred not only in the salve boxes, but also in the glasses, as well as in the pots in which the beetles oviposited. It was got over by subjecting the fibre to steam at 70°C for 15 minutes in a sterilizer. At the height of the rearing experiments all the fibre in the pots in which oviposition took placed was changed after every lot of eggs was collected, that is at intervals with a maximum of a week, for freshly sterilized material.

The salve-box method of rearing larvae which has been used by other workers was tried first, but soon difficulties were experienced and the method was discontinued in favour of the drinking-glass method to be described. High mortality occurred amongst the larvae in the salve boxes, both in newly emerged as well as full grown larvae obtained in the field, and it was evident that some chemical reaction was taking place between the damp fibre and the metal of the boxes, apparent as a blackening of the fibre which came in direct contact with the metal, and which was inimical to the larvae, while with the damp soil corrosion of the boxes occurred, which proved fatal likewise.

After further trials, ½-pint drinking glasses of abont 4½-inches in height and 2½ inches diameter were adopted as suitable receptacles for the rearing of the larvae, and subsequently these were used throughout the work. On emergence of the larvae in the glasses with fibre, they were removed as soon as possible to glasses containing soil with which was intermixed grass roots and decomposing grass and other organic matter. This material was previously moistened to a degree which was considered satisfactory and the glasses filled to a height of about 3½ inches, above the soil a wad of dried or partly-dried grass was placed. This wad of grass proved highly important in conserving the moisture and maintaining the soil in the condition in which it was placed in the glasses. In this material the larvae developed satisfactorily, and as the larvae passed the first instar and became more powerful feeders grains of germinated maize were added and on which they fed, although it was not essential for their existense.

As a precaution against the attacks of rats the glasses containing larvae were placed in wooden boxes turned on their sides, the lids having an area cut out and screened to provide ventilation. Large boxes were divided with a shelf or shelves according to size.

PERIODICITY OF OUTBREAKS

Inquiries in the district, as stated previously, have brought to light imformation on previous outbreaks, and it is noticeable that wherever extensive outbreaks have been observed that they have occurred at intervals of about nine years, thus it is stated that there was a severe outbreak in 1900, another somewhere between 1907 and 1909, again in 1918 and the latest in 1927. This periodicity is somewhat striking and will be found on the comparison with the meteorological data from the District to show some correlation with periods of comparative dryness occurring between November and December. In normal years the end-year wet season commences early in November and continues until February.

Laboratory rearing showed that the larvae as a whole, but especially the young larvae, are particularly susceptible to even small excesses of moisture, and when this fact is considered along with the data on previous outbreaks of the pest it is to be inferred that the end-year rains exert a decided and important check on the increase of this insect. In years in which the precipitation at this time is below normal this controlling influence would be withheld, and it is

possible that the periodic outbreaks of the insect may be, in part at least, thus explained. Although such conditions may be of considerable importance *per se* they may have in addition a direct bearing on the natural enemies of the insect which must not be lost sight of, especially as one important natural enemy of the insect is a fungus of the genus *Metarrihizium.*

SPECIES SOMETIMES MISTAKEN FOR LIGYRUS EBENUS DEG.

Other beetles occur in the North Western District which may be confused with *Ligyrus ebenus* DeG. especially in the larval and pupal stages, and for this reason it has been considered desirable to mention these insects. The species most likely to be mistaken is *Dyscinetus geminatus* F., but actually the larvae of a common June Beetle *Gymnetis maculosa* Oliv. have been handed to the writer as well for " white worms," while the pupae also are not distinguished by the farmers in the District. Occasionally the larvae of *Phileureus didymus* L. in their younger stages are confused in this way, but as they reach maturity their very much larger size discriminates them.

No attempt will be made here to give descriptions of these insects and their various stages.

NATURAL ENEMIES

Little information has been obtained during the investigations on the natural enemies of the Tannia Beetle. No parasites were reared from the material collected in the District during the past two years.

The eggs, in the laboratory, were severely attacked by mites as mentioned elsewhere, and it is probable that under natural conditions they exert a similar check on this stage of the insect.

The larvae were found to be occasionally preyed upon by the larvae of an Elaterid beetle, but it has not been possible to rear this insect.

Hawks, and other birds as well, must be looked upon as natural enemies of this insect. While no data are available concerning this insect, when engaged in the study of another closely related beetle, the Larger Hardback *Dyscinetus geminatus* F., which is found under somewhat similar conditions, the writer observed the common Chima-chima Hawk ("Chicken Hawk") *Milvago chima-chima*, to feed on the larvae of those insects.

Larvae in all stages of development, pupae, and adult beetles are all severely attacked by a fungus, which has been identified by Dr. H. R. Briton-Jones of The Imperial College of Tropical Agriculture, Trinidad, as *Metarrhizium anisopliae.* This fungus is the Green Muscardine or Froghopper Fungus, and is a recognised enemy of beetles of this group as well as other insects. In the present instance its controlling influence on the Tannia Beetle is important, and the mortality caused to the various stages of this insect in the North Western District is high. Plate III, Fig. 2, shows a larva and pupa

that have been killed by this fungus, and gives a good idea of the general appearance of insects so killed. In Plate II, Fig. 2, the larva has been attacked also, as indicated by the darkened areas occurring on the upper abdominal segments, a condition that was frequently found in the investigation.

CONTROL MEASURES

In the study of the life history and habits of the Tannia Beetle in the laboratory and field certain points have been elucidated which it would appear may be applied with advantage in attempts to control the insect. In the first instance it is evident while the insect may, and probably does breed in the swampy areas adjoining the farms, conditions on the farms themselves are entirely suitable to the propagation of the insect, and it is not believed that any serious infestation of the farms occurs from the swamy lands. For this reason it is evident that control measures can be directed against the insect with advantage when it appears in such numbers as to warrant this. A number of methods will be recommended now that may be used in combating the insect, and the particular method to be used on each farm will depend on the conditions prevailing.

LATE PLANTING

Late planting is a method avoiding attack, and has been practised to some extent in the District already. After the first crop of tannias is reaped about April or May it is customary to replant the field in two or three weeks, but if this is done the sets or "bottoms" may be attacked by adult beetles or even late larvae. If planting be delayed until June or July it has been found that the damage will be consiberably reduced although perhaps not entirely eliminated.

TARRING SETS

Damage to sets or "bottoms" may be further reduced, and even brought to a minimum, if prior to planting the cut surfaces are treated with hot tar. Such applications of tar protect the cut surface, and in this way lessens their attractiveness to the beetles.

FIELD SANITATION

Both larvae and adult beetles are readily attracted to decaying vegetable matter and feed readily on it, and rotting tannias left in the ground or about the fields offer a ready and ideal source of food to the insects. It is desirable, therefore, that when fields are reaped that this should be thoroughly carried out and all material in the form of tannia tubers removed. This is not the general practice in the District, in fact large quantities of such material is regularly left in the fields. Plate IV shows the typical condition of a field in the North Western District after reaping has been carried out. A large amount of this material would be valuable as food for hogs, and on occasions it may be possible to turn the hogs directly into the fields.

WHITE *versus* YELLOW TANNIAS

From observations and inquiries in the District it would appear that the variety of this crop known as the White Tannia is less injured than the other variety or Yellow Tannia, although not entirely free from attack. It would be advantageous, therefore, to plant more of the former variety in areas and during periods when the attacks of the beetle are more prevalent. There appears to be a certain amount of preference to the Yellow Tannia as a food, but whether there is any real reason for this it has not been possible to find out. In fact certain farmers and other individuals in the District have expressed a decided preference as regards flavour for the White Tannia and affirm that the prices obtained for the produce, if not better, is certainly not inferior to those obained for the Yellow Tannia.

FLOODING

That the larvae of this insect in all stages of development are particularly susceptible to even small excesses of moisture in the soil has been shown already, and this offers an efficient means of controlling the insect, at least in some areas in the District, as even short periods of flooding the land will completely destroy both larvae and pupae. In areas adjoining rivers where the water is fresh it is recommended therefore, that short flooding of about 10 hours be given to the fields after the tannia crop has been removed, provided that there are no root or other crops in the ground that would suffer thereby.

SOIL INSECTICIDE

Still another method of control which may be tried is the application of a caustic solution to the ground. A solution composed of Caustic Soda (commercial) 5¼ lb., Disinfectant Fluid (Rideal Walker co-efficient 18-20) 1 gall., Washing Soda 10 lb., water 5½ gall. is prepared, the caustic soda being first dissolved in the water and the other ingredients added in the order given. This is the stock solution and for use is diluted with water at the rate of 1 gallon stock solution in 360 gallons water. The diluted solution is applied at the rate of two pints per square foot of ground. The solution can be applied by means of spraying machines or even with an ordinary watering can.

The solution should be applied to soil that is in a moist condition, and it may be necessary at times to wet the soil before the application of the solution is commenced in order to fulfil this condition.

Further experiments with this insecticide are necessary, but in the meantime the formula has been given in order to allow persons desirous of undertaking trials themselves to do so.

SUMMARY

The Tannia Beetle, *Ligyrus ebenus* De G, is an important pest of that crop in the North Western District.

PLATE IV.

Photo] [L. D. Cleare Jr

TANNIA FIELD IN NORTH WESTERN DISTRICT

The Tannia crop has been reaped recently. Young Coffee plants shown by arrows.

The habits of the insect are dealt with, and the nature of the injury caused by both the "white grubs" and adults is described.

The life history of the insect is given, and the various stages of the insect described, as well as the methods of collecting and rearing used in the investigation.

There appears to be a periodicity in the outbreaks of the insect of about nine years which shows some correlation with meteorological conditions.

Little information has been obtained with regard to the natural enemies of the insect, but the fungus *Metarrhizium anisopliae* causes a high mortality amongst the larvae, pupae and adult stages of the insect.

Control measures are recommended which include late planting, treatment of sets with tar, field sanitation, flooding, the use of an insecticide.

ACKNOWLEDGEMENTS

In conclusion I would like to express my thanks to Mr. H. Thompson King, Commissioner of North Western District, and Mr. P. C. Pierre, for assistance given me in the District. Mr. C. Williams, Laboratory Assistant in this Division, has assisted in the rearing of the insect in the laboratory.

THE DESTRUCTION OF COUSHI ANTS WITH CARBON BISULPHIDE.

BY

L. D. CLEARE, Jnr., F.L.S., F.E.S.

Government Entomologist, British Guiana.

COUSHI ANTS.

WHAT THEY ARE.

Leaf cutting, or "Coushi" ants as they are called locally, are peculiar to Tropical America where they are amongst the most generally destructive insects. In some districts in British Guiana they are troublesome pests. In this Colony several species of Coushi ants are found, the commonest and most destructive of these being the large mound-building species, *Atta cephalotes* L. This species occurs commonly in the coastal area, and on this account its attacks on cultivated plants are more general than the other species. In certain districts, such as the North Western District, where there are forest areas in proximity to the cultivations, other species also attack crops. Among these are *Atta* (*Acromyrmex*) *octospina* Reich., and *Atta laevigata* Sm., which although destructive, are not as damaging as the previously mentioned species. The various species of coushi ants have somewhat different habits, and these will be dealt with later.

HOW THEY LIVE.

The peculiar habit of these ants of cutting off pieces of the leaves of various plants which they carry to their nests held upright in their jaws, and the long processions which they form in doing so, are familiar to many persons who have lived in the Colony. Regular paths are formed by the ants extending in different directions from the nest, often for a considerable distance, and in this way access is obtained to various areas. When a tree or plant is met with bearing leaves which are suitable for their purposes the ants ascend it in numbers, and beginning at the edge of a leaf each ant cuts out a semicircular piece about half-inch in diameter, lifts it upright between its jaws and descends to the ground. The ants then return to the nest with the pieces of leaf, and along the paths lands of these insects may be seen moving in opposite directions, some laden with pieces of leaf returning to the nest, others hurrying outwards for further supplies.

The pieces of leaf having been deposited in the nest, are cut up very finely and kneaded into a yellowish-brown spongy mass and are not eaten by the ants as is the popular belief. On this spongy mass a fungus later grows, and on this fungus the ants feed. The ants which cut up the leaves into tiny pieces are much

smaller than the individuals which collect them and never go out of the nest, they may be considered the gardeners of the community, their duty being to attend to the growing of the fungus on which all the ants of the nest feed.

In a nest of mound-building coushi ants* there are six different castes, namely, the queen or female, the male, the soldier, and the workers themselves comprising of three forms, the leaf-cutters or foragers, the gardeners and the nurses The queen is a large dark-brown, fat-bodied creature about three quarter-inch long and bearing two pairs of wings; her whole duty is to lay eggs and so keep up the number of ants. The male is also winged, but is somewhat smaller than the queen with a smaller head. The soldiers have large heads and powerful jaws, and their function is to defend the nest.

The nests of the mound-building coushi ants are usually large and may often be 30 feet or more across, and contain literally thousands of ants. The position of a nest of this species is marked by a mound of earth often of a different colour to the surrounding soil, and sometimes as much as three feet above its level, with a number of openings. These openings are the entrances and exits of the nest, and communicate with the numerous underground galleries which run in different directions and which connect up the several fungus gardens of the nest. About these openings there may be accumulations of soil and of the yellow-brown spongy substance brought up from the gardens below.

With some of the other species nest-building is not carried out on so large a scale, indeed the nest of a community may be quite a small affair. The nests are built also in a more secretive manner, and may be found under logs or within them, under large stones, or even in hollows in the wooden pillars supporting houses. Some of these species at least do not have soldiers, and this may account in part for their more secretive habits of nesting.

CARBON BISULPHIDE.

WHAT IT IS.

Carbon bisulphide is a liquid one-fourth heavier than water. It is very volatile, evaporating rapidly when exposed to the air. IT IS HIGHLY INFLAMMABLE AND ITS VAPOUR WHEN MIXED WITH AIR EXPLODES WHEN IGNITED. Ignition may occur if the vapour comes in contact with substances at temperatures even below visible redness. The commercial article has a slightly yellowish colour, and a fetid odour. The vapour is heavier than air and always tends to flow downwards.

ITS DANGERS.

On acount of the highly inflammable nature of carbon bisulphide, great care should be exercised in its use and storage. On no account should a flame, match, or even a lighted cigarette or pipe be brought in its vicinity.

**Atta cephalotes* L.

Small quantities may be kept in closely-stoppered bottles, but care should be taken to see that the stoppers or corks are tight and there is no escape of vapour. Bottles containing this substance should be kept in safe places away from children and unauthorised persons. It is best kept in metal receptacles, such as drums for large quantities, and metal bottles for smaller amounts. Care should be taken to ensure that there are no leaks in these receptacles, and, as with other containers, that there is no escape of vapour through the stopper. The vapour should not be inhaled in any quantity as it causes dizziness and palpitation of the heart. For this reason, when handling the substance it should be arranged to have the liquid as low as possible. Fresh air is the best treatment in case of a person becoming affected by the vapour. Receptacles containing this substance should be labelled CARBON BISULPHIDE, HIGHLY INFLAMMABLE.

METHOD OF DESTRUCTION.

MOUND-BUILDING SPECIES.

The nest that it is desired to destroy having been located, should be cleaned of all weeds and 'bush' both about the nest itself and its immediate surroundings until the entire size of the nest is ascertained, and all openings made visible. There may be some difficulty in accomplishing this on occasions, but in order to make destruction certain it is necessary, and should be persisted with until successful.

According to the size of the nest, one or more of the large exit holes are then decided upon as suitable for the application of the carbon bisulphide, and in order that they should not be mistaken in later operations they may be marked by placing a twig in each. All the remaining holes are now carefully and thoroughly closed with earth. It is best before commencing this work to have clods of earth preferably wet, placed beside each hole so that the operation may be quickly accomplished and the minimum amount of bites inflicted on the persons performing the work. Similar clods of earth should be placed beside the holes in which the carbon bisulphide will be poured.

Before the receptacle containing the carbon bisulphide is opened care should be taken to ensure that no one is smoking in the vicinity of the operations. This is a little precaution that may be overlooked easily and may lead to disastrous results.

Down each of the marked holes a couple of fluid ounces of carbon bisulphide are then poured, the marking twigs withdrawn, and the holes closed lightly for a few minutes. In the meantime a torch is constructed of dried "bush" tied to a long stick. The holes are then uncovered and the torch set alight and applied to the mouth of these holes. The necessity for having a long stick will then be apparent, for as soon as the flames are applied to the first hole a violent underground explosion takes place, which is repeated at varying intervals as the flames of the first explosion penetrates the distant underground galleries of the nest. All

the holes that have received carbon bisulphide are thus treated, and then closed tightly with earth. A watch should be kept for fumes arising from holes or crevices that have been overlorked in the first instance and these should likewise be closed with earth.

With the exercise of the necessary precautions in the use of carbon bisulphide, and the various operations properly carried out, this method of destroying coushi ants is perfectly successful. The largest nests may thus be destroyed, usually in one operation, and it is only very rarely that more than a second treatment is required. Its advantages lie in the fact that no special appliances are necessary.

Other Species.

As has been pointed out previously, some of the other species of coushi ants which attack crops in areas in proximity to forests, construct smaller nests in positions that are usually somewhat inaccessible in comparison with the mound-building forms, and for this reason the method of destruction advocated above cannot always be applied. The destruction of the nests of such insects may be accomplished, however, by applying carbon bisulphide directly into the nest and closing it tightly with earth. Some difficulty may be encountered in inserting the carbon bisulphide into the nest if it is attempted to do this by pouring it from a bottle or other container, while there is sure to be a good deal of waste of the chemical in the effort to do so. The operation may be performed with ease and little waste, however, if the carbon bisulphide is introduced into the nest by means of an oil-can. The type most suitable for this purpose, where a number of nests are to be destroyed, is the long-spouted variety known generally as an engineer's oiler, which may be obtained in different sizes, those with a capacity of half-pint costing one dollar ($1.00) retail in Georgetown. But for smaller quantities of the chemical, even machine, motor-car, or large-size bicycle oil-cans may be employed.

THE SCLEROTIUM DISEASE OF COFFEE.

SOME NOTES ON THE ORIGIN OF THE DISEASE, ITS OUTBREAK, AND CONTROL.

BY

E. B. MARTYN, B.A.

Botanist and Mycologist, British Guiana.

If an examination be made of any collection of dead leaves on coffee grants of the North West District affected with Sclerotium Disease, (*S. coffeicolum* Stahel), the orange sclerotia and feathery white mycelium of the fungus will be found occurring plentifully on the damp underlying leaves. The fungus was readily found in this stage in April, when little or no infection of the coffee bushes was visible. At the same time, in the forests west of the Aruka River and the cultivated area, the writer found upon decaying leaves sclerotia and mycelium similar to those found beneath the coffee bushes. Later in the year, when it was possible to compare cultures obtained from the bristles of *S. coffeicolum* on diseased coffee berries, with those from sclerotia collected both in the forest and on the coffee grants, an apparently identical fungus was obtained in each case.

This suggested that the fungus in question occurred normally as a saprophyte on decaying leaf tissues, but was also a potential weak parasite, which under suitable circumstances was able to obtain a foothold on living plants. In the case of Liberian coffee Stahel [1] has pointed out that the parasitic action of the fungus on leaves is confined to the penetration of the stomata and cuticle, the hyphæ then entering the dead cells. Further cells are killed in advance of penetration by the action of a toxic substance, probably Oxalic acid, and the fungus continues its life on the plant as a saprophyte.

Hitherto, apart from Liberian coffee and one or two other varieties, the fungus has only been observed as a leaf parasite upon young plants of *Cecropia peltata* L. (Congo Pump). Last September, however, the white bristles characteristic of this fungus were found upon leaf spots on a number of other common weeds growing in the coffee grants. On *Commelina nudiflora* L. (Cana or Zeb grass) they occurred plentifully, and were easily found on *Vitis sicyoides* Miq. (Snake Bush), the leaves of both plants showing spots to a quarter of an inch in diameter, with typical concentric rings. On an unidentified Melastomaceous weed, small brown spots were occasionally found on the leaves, with one or two bristles on each. On *Blechnum serrulatum* (Rich.) L.,-a fern growing extensively beneath the coffee bushes, a number of pinnae showed brown, dried patches, and in a few cases one or two bristles were to be seen on these.

These observations were made on the Aruka River, but a case was seen elsewhere in the North West District (at Baramanni Police Station) in which typical pots and bristles occurred on the lower-leaves of some ornamental bushes of *Gardenia ?jasminoides* Ellis (Christmas Rose). In this instance a few bushes of Liberian coffee which occur nearby showed no signs of the disease at the time of observation, which was September.

In every case so far, however, the appearance of the fungus on living plants had always been in the immediate neighbourhood of coffee bushes. It was of interest then, when the unmistakable bristles were found (in October) on the leaves of a shrub or young tree near the first falls on the Essequibo River, far removed from any cultivation. The plant, some 10 feet high, was unidentifiable. It was growing near the water's edge, in a rather open situation, where a small area of the immediately surrounding forest had been cleared some time previously, and had reverted to a state of secondary bush. On the large palmate leaves were small white spots, with a brown border, about one tenth of an inch in diameter, which increased in size to large patches, with a maximum breadth of one inch, and from which the dead central tissue had in many cases fallen away. No definite concentric rings appeared, but the bristles occurred plentifully. On decaying remains of fruits and leaves below the plant, orange sclerotia and the typical white mycelium were also to be found. Cultures prepared from the sclerotia in every way resembled those of *S. coffeicolum*. In addition, the sclerotia of the fungus were found upon dead leaves in the forest in this same neighbourhood.

INOCULATION EXPERIMENTS.

To establish the indentity of the fungus found on the coffee bushes with that occurring saprophytically on dead leaves in the forest, it was desirable to carry out inoculation experiments with cultures obtained from both sources. No mature trees of Liberian coffee being readily available, an attempt was made with seedlings. These were put under bell jars, and portions of mycelium placed on the leaves and stems. Provided the atmosphere was kept sufficiently damp, the mycelium made some superficial growth on the surface of the leaves, but no penetration took place. Even when leaves were wounded by pricking, the fungus did not attack them. Possibly better results would have been obtained with bristles, although young leaves and seedlings are seldom attacked even under natural conditions. Repeated attempts to produce the bristles in culture, however, on finely cut and sterilised Liberian coffee leaves, as advocated by Stahel, [1] were unsuccessful, and they never appeared on the Corn Meal Agar media which was otherwise employed.

Inoculation of seedlings having failed, a number of ripe berries of Liberian coffee were obtained, and sterilised by immersion in dilute Mercuric Chloride, after which they were washed in sterile water. Sixteen of these were placed in each of two glass chambers in which a damp atmosphere was maintained, and were inoculated respectively with the mycelium of the fungus obtained from the two

sources, half of them being wounded first. A number of uninoculated berries, some also wounded, were kept under similar conditions as a control. After a week to 10 days, four of the inoculated wounded berries in both chambers had turned brown over the greater part of the surface, the latter being covered with the mycelium of the fungus. A number of aerial rhizomorphs arose, which, however, lacked the rigidity and uniformity of the true bristles. On placing attacked berries in a drier atmosphere, these rhizomorphs shrivelled, and no bristles were formed. If the berries remained in a damp atmosphere, sclerotia developed after about a fortnight from the time of inoculation. The unwounded berries were not attacked.

Establishment of the Fungus upon Living Plants.

It would appear from the above observations that *Sclerotium coffeicolum* is a fungus which is of quite common occurrence as a saprophyte upon decaying vegetable matter, but which under favourable circumstances is able to gain a foothold on the leaves of living plants. The difficulty of securing successful inoculations, and the rarity with which living plants are found attacked, outside a few cultivated areas (even in regions where the sclerotia and rhizomorphs are of comparatively common occurrence) suggests that the fungus is not only a very weak parasite, but is also unable to attack the aerial parts of plants, as lacking any means of dispersal.

The only means by which the fungus can spread itself effectively above ground is by the formation of bristles. From the scarcity with which these are found, apart from the small areas where the fungus has established itself on coffee, and the difficulty of producing them in the laboratory, it would seem that the conditions suited to their appearance are strictly limited. The bristles when formed, however, contain a high percentage of Calcium Oxalate (to crystals of which they owe their rigidity) [1]and apparently when they fall on the green leaves of plants, these may suffer the initial penetration of the fungus under suitably moist conditions. This results in leaf spots of varying dimensions, according to the ability of the plant to form a callus limiting the action of the fungus, or to the continuation or otherwise of those conditions suited to its development. For active growth the fungus needs continual moisture, and it is only when such prevails to an extreme degree, that the rhizomorphs appear on infected coffee bushes.

Liberian coffee, when seldom topped or pruned, and growing so close that neighbouring trees often overlap, gives a mass of thick foliage amongst the lower branches of which conditions are peculiarly suitable for the establishment and development of the fungus. The large fleshy berries seem too, when ripening, to form a particularly favourable substrate on which enormous numbers of bristles may be produced. These then spread the infection on coffee and on the leaves of other neighbouring plants.

OUTBREAKS OF THE DISEASE ON COFFEE.

The occurrence of the Sclerotium disease on coffee is confined in British Guiana, so far as is known, to a comparatively small area in the North West District, where the coffee grants are closely surrounded by forest. Liberian coffee is grown on the Pomeroon River, but the disease has never been reported in that locality. The cultivated land there, however, is not so closely surrounded by forest as in the North West, the neighbouring country being more of the nature of swamp savannah, in which it is probable that the saprophytic stage of the fungus does not occur, at any rate commonly. The non-appearance of the disease here, and in some other small coffee growing localities, must be ascribed either to the absence of the fungus, or more probably to the non-occurrence of those conditions most suited to the development of the bristles.

In the North West District, the disease invariably becomes prevalent in August or September, when the long wet season ends, being worst when there is less rain at this period than usual. Last year's outbreak for instance was very mild compared with that of 1928, and it is noteworthy that the rainfall at Hosororo, during what may be described as the critical period for the disease (namely the second dry season) was considerably higher in 1929 than it had been in the preceding year, the total for September being nearly double that of 1928. Neither in 1926 or 1927 was the disease serious, and in both years the September rainfall was high compared with that of 1928, when a bad outbreak occurred. Normally the disease persists for two or three months, getting less towards the end of the year. In the 1925-26 drought however, when the December rainfall was considerably below normal, the attack was prolonged into the following year.

The disease does not spread though during the first dry season of the year. An examination of the daily rainfall records at Hosororo since 1925 reveals the fact that the average daily precipitation from the latter half of August to the beginning of November, taken in fortnightly periods, lies very regularly between an approximate minimum of 0.15 inches and maximum of 0.41 inches, whereas from mid February to mid April the average, over the same period, though in one year reaching a maximum of 0.40 inches lies for the most part between 0.0 and 0.23 inches. It would appear from this, that the formation of bristles is favoured by drier, but not too dry conditions. During the dry season heavy mists hang over the rivers and the adjoining coffee grants, and these provide the necessary moisture for the fungus if rain is lacking. It is possible that sudden changes in the degree of humidity provide the conditions suited to formation of bristles, but a certain minimum humidity is necessary for the further development of the fungus.

CONTROL OF THE DISEASE.

It is apparent that control measures should primarily be aimed at avoiding as far as possible those conditions which favour the development of the fungus. Proper pruning and spacing of the trees, allowing of better ventilation, is therefore to be advocated. It is obvious also that every effort should be made to

remove dead leaves, etc., taking particular care to avoid the collection of these in heaps, such becoming thickly infested with the sclerotia and rhizomorphs of the fungus.

In years when the attack is of a minor degree, the amount of damage done is small, and very little loss is sustained from the fungus. In bad outbreaks, however, considerable loss is caused at the time, in addition to which more far-reaching damage is done to the trees.(2) As an instance of this, several trees were noted in 1929, which though little affected by the disease, bore branches almost bare of fruit, the after effects of the fungus, which had been observed as being especially plentiful on these same trees in the preceding year.

In order to estimate what benefits are likely to accrue from spraying with Bordeaux mixture, and whether this will produce a sufficient increase in crop to justify the expense entailed, a series of experimental sprayings were carried out last September. The results must await the completed picking of the crop, and the experiment will have to be repeated for more than one season before reliable information can be obtained. As the outbreak last year was slight, it will not be possible to obtain a fair estimate of benefit of spraying to counteract the disease, but data as to costs have been secured. Should spraying prove to be not economically worth while in normal years, though justifying the expenditure when the outbreak of the disease is serious, it should be possible for farmers to foretell when a bad attack is impending, and spray their crops accordingly. The inference at present seems to be that a sudden falling off in rainfall at the end of August, followed by a dry September, are conditions presaging an abnormal attack. In considering the benefits of spraying, however, factors other than the direct increase in crop must be considered, such as cases in which an increase in yield might be negatived owing to inability to harvest the whole of the augmented crop. Loss due to shortage of labour is not uncommon in the district.

Details of Experimental Spraying.

Experiments have been inaugurated upon two grants to test the efficacy of varying strengths of Bordeaux mixture. On one grant the trees are topped and seldom exceeds a height of 8-10 feet, whereas on the other they are untopped, and are sometimes 20 feet high or more. The general scheme has been to spray alternate beds, leaving the intermediate beds as controls. The total areas sprayed on the two grants were approximately ten and sixteen acres respectively. Bordeaux mixture of 1%, 1.6% and 2% consistency was used on different sets of beds, and on one grant Resin was used as an adhesive, this effect being obtained on the other by use of a double quantity of Lime. The machines employed were compressed air sprayers of the knapsack type.

The contrast in cost of spraying topped as opposed to untopped trees was very marked. In the case of the untopped trees, the rate of application of the mixture was between 200 and 250 gallons per acre, the cost of labour (not inclu-

sive of supervision) being $3.50 per acre, and the total cost per acre, inclusive of materials, but not including the initial cost of the machines, was between $6.50 and $7.00 per acre, according to the materials used. Where the trees were topped low, the spray was applied at an average rate of 70 gallons per acre, the labour costing $1.15 per acre and the total cost, reckoned as above, varying between $2.20 and $2.50 per acre.

CONCLUSION.

It appears that *S. coffeicolum* is a species of Sclerotium, living normally as a saprophyte upon decayed vegetable matter, which is able under certain circumstances to attack the tissues of living plants. To enable it to do this extensively however, it is necessary for the motile organs of the fungus to be produced, namely the peculiar rigid bristles, but conditions suited to the formation of these are limited, and apparently in the natural environment of the fungus are seldom attained.

It is of interest to compare *S. coffeicolum* with *S. rolfsii*, of which Nakata, in his studies on the latter fungus, regarded it as a strain. (3) *S. coffeicolum* differs from *S. rolfsii* in the fact that it is a weaker parasite, and attacks the aerial portions of plants and not the root and base of the stem. Its comparatively wide range of hosts is a point in common with the other fungus, although conditions suitable for its attack are less generalised. By a combination of suitable circumstances, this species of *Sclerotium* has established itself upon Liberian coffee in certain localities, and finds in this plant, as grown under cultivation, a well adapted host. But normally at only one season of the year do conditions occur suited both to the production of bristles and the further development of the fungus. When the conditions are especially favourable, the fungus may spread on the coffee to an alarming extent. These major outbreaks, however, are apparently of irregular occurrence, the damage done by the fungus in normal years being comparatively slight.

SUMMARY.

(1) Sclerotia and rhizomorphs of *S. coffeicolum*, similiar to those found on debris beneath coffee bushes, were discovered upon dead leaves in the neighbouring forests in the North West District, and also elsewhere.

(2) The unmistakable bristles of the fungus were seen on the leaves of a number of plants other than coffee in the North West District, and in one case were found upon a wild plant in another part of the Colony.

(3) Similarity of appearance both in nature and in artificial culture, together with results of inoculation experiments, showed the fungus found on dead leaves in the forests to be identical with that causing the disease of coffee bushes.

(4) Observations point to the fungus being a fairly common saprophyte, which is able under suitable circumstances to attack living plants, the essential factor in this attack being the formation of the bristles.

(5) The periodic outbreaks of the disease are discussed, and it is suggested that optimum conditions for the latter only arise in the dry spell following the long wet season, a certain minimum humidity, however, being necessary for the development of the fungus.

(6) Control measures are indicated and spraying experiments outlined, together with details as to cost.

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CATTLE IN THE COASTAL BELT.

BY

MAJOR T. BONE, O.B.E., M.R.C.V.S.

Government Veterinary Surgeon, British Guiana.

In the coastal belt of the Colony approximately 50 per cent. of the cattle exist on a maintenance ration only, 25 per cent. obtain sufficient food to enable them to do a little work or yield a small supply of milk, and only 25 per cent. are fed for hard work, market condition, or up to their milk capacity. This means that 50 per cent. are a financial burden to their owners of doubtful value, 25 per cent. scarcely pay for their keep, and only 25 per cent. can be considered profitable.

There are upwards of 70,000 head of cattle on the coastlands, and the existence of half of them is solely due to that they fend for themselves and multiply under any conditions.

When the grazing was less restricted than it is to-day it is possible that the pastures supported this number of cattle and maintained them in fair condition. It is, however, now evident that the pastures are over-stocked. Each year more and more of the better pasture land is being cultivated, and unless the system of cattle management is changed the 50 per cent. which are now existing on a maintenance ration will soon be on a starvation diet. The nature of the land, the difficulty of drainage, and the heavy rainfall are all against successful breeding and rearing of cattle in small areas under the present system.

When the grazing was more or less unrestricted it was possible for cattle to roam over the wet savannahs without doing much damage to the pasture, but now the trampling of many cattle over small areas kills off the herbage. When struggling knee-deep and girth-deep in mud and water, the animals at each step, for every mouthful of herbage eaten, trample four out of existence. And when this over-stocked and trampled land is dry it is packed and hard and grows only a few worthless weeds.

The time has arrived when either the number of cattle will have to be reduced or the system of management changed. It is probable that the peasants who own most of the stock will not take kindly to a change of system. The present method of animal husbandry suits them in that it involves the minimum amount of labour; cows in milk are kept near the houses and fed with cut grass and dry cows, calves and steers are turned out on to the savannahs to fend for themselves. Most of the peasants are stock-owners of necessity rather than inclination. They require milk and so keep a few cows, and they are prepared to keep the young stock which are born each year provided that they require neither care nor labour.

In any case, the peasants are not in a position to alter the conditions under which stock are kept ; this is only possible for land-owners.

To breed and rear stock successfully in the coastal belt a more intensive system of management is required. And a system of this kind requires both labour and capital.

A few of the more favoured grazing areas only require to be fenced and divided into paddocks, before a more intensive system of management can be practised. The cattle should be collected in two or more paddocks according to sex and age. The length of time it will be possible to keep them in these paddocks will depend on the weather and the amount of grazing. When it is necessary to transfer the cattle to adjoining paddocks these evacuated paddocks should be lightly cultivated, and if necessary sown with good fodder grasses. After a few months of this practice the whole of the pasture will be improved, and it will be possible to move the cattle at shorter intervals so saving labour over the evacuated paddocks. Unfortunately, there are few grazing areas which can be so easily managed. Many of them are flooded periodically and some have large swamps, Grazing areas of this type will need two or more permanent corrals. The corrals will be required for use when the pastures are under water, and will require firm solid floors of burnt earth or some such material.

The animals in the corrals will have to be fed with cut grass placed in racks. The grazing of paddocks in rotation and the care of the pasture will not only improve the condition of the cattle but will also allow of more animals being kept on any given area than at present. Over-stocking will be easily avoided, and the detection of sick and worthless animals be made simple. On each agistment area where milch cows are kept there should be a milking shed, and attached to the shed should be a plant for the cleansing and sterilising of milking utensils. Land-owners running their own herds under this system will have no difficulty, but it will not be simple to manage agisted cattle in this manner. The problem of labour on agistment areas might be solved by increasing the agistment fees and using the money so obtained to employ certain of the cattle owners on certain days. Milch cows and calves would, of course, have to be attended by their owners at milking time.

There is considerable labour and expense attached to the system advocated, and for it to be profitable the poor type of cattle will have to be eliminated. Breeding indiscriminately from any class of animal will have to stop. The cows for breeding will have to be selected and good bulls used. With improvement of the pasture it will pay to use bulls of improved breeds.

Compared with other stock-raising countries the Colony is practically free from contagious and infectious diseases of animals, and the climate allows of green fodder being grown all the year round. These are advantages which will make careful cattle-management profitable.

The pasture of the stock-farm at Georgetown may be considered the average pasture of protected land which is not over-stocked in any part of the coastal belt. In practice it has proved sufficiently good to keep working oxen in good hard condition without supplementary feeding, but it is not good enough to make these oxen gain prime condition when at rest for a long period. Cows in milk and young stock on this pasture require supplementary rations. The indication is that it will not be possible to obtain prime meat animals off the savannahs unless the pasture is improved or supplementary rations are fed. Improved pasture is the cheaper form of feeding and efforts are being made on these lines. The market prices make any form of supplementary feeding impractical.

The feeding of milch cows is on a different footing. Elephant grass which grows luxuriantly in the Experimental Station may be worth growing in some areas but it is not the valuable fodder in the coastal belt which it has proved to be in other countries. Uba cane grows well anywhere and is of some value. Guinea corn has been grown in the Experimental Station and may prove to be valuable. Pigeon peas grow well and are undoubtedly good fodder. One of our progressive farmers has grown a good stand of cow peas. On the stock-farm the plant locally known as Demerara Primrose has proved to be most valuable. It is grown as an ornamental plant in the Botanic Gardens. It grows luxuriantly on heavy clay soil wherever there is shade, and would probably grow in the coconut plantations adjoining agistment areas. It can be grazed or fed to animals. It can be fed alone, or as is the custom on the stock-farm, half and half with grass. Two dry cows grazed on half an acre of Primrose and fed with grass at night, maintained excellent condition for a period of two months. The Primrose would have supported them for a longer period, but it was necessary to move the animals to other quarters. Stall-fed imported Canadian cattle at first refused the grass fed to them, but ate the Primrose readily. It increases the milk supply of milch cows, and in cases of sickness, when both grass and concentrates have been refused, the Primrose has been eaten readily. Incidentally it is a good fodder for pigs, especially those which are confined to styes.

The feeding value of this plant which has been proved in practice over a period of twelve months is corroborated by the analysis made by the Government Chemist-Ecologist.

In spite of the restricted grazing there are so many advantages for raising cattle in the coastal belt that the establishment of a profitable cattle industry should be a comparatively easy matter. No experiments are required to prove that cattle will breed. They can be seen everywhere and anywhere, on the savannahs, in the swamps, on the roads and under houses.

Fences, paddocks, corrals for use at certain seasons, grazing the paddocks in rotation and reasonable care of the pasture, will solve the difficulty of feeding store cattle and dry cows. Improvement of the pasture will make the production

of prime meat animals possible, and also increase the milk supply of the average milch cows.

For deep-milking cows something more will have to be done if they are to yield a milk supply up to their capacity. Concentrates will have to be fed. At the present time locally grown foodstuffs suitable for cattle are more expensive than similar foodstuffs which are imported, and the imported foodstuffs are not cheap.

There are few countries which can grow all the food-stuffs suitable for feeding to cattle, but at the moment the Colony can grow none which can be fed economically. The only one which is more or less reasonable in price is broken rice and it is of the least value. Maize is grown but the sale price is prohibitive. What is locally known as "kanchi," the residue of the coconut after the oil has been expressed, is of value but is difficult to obtain. So-called "rice dust," a mixture of rice bran, broken rice and hulls, has a feeding value provided that it is used in small quantities and with care. Molasses is cheap and can be used in reasonable quantities. Perhaps rice millers will one day produce rice bran, and agriculturists find it possible to grow and sell produce at a reasonable rate for stock-feeding.

The interest of land-owners is required to make cattle raising profitable. The industry cannot be left in the hands of peasants, few of whom know anything about modern methods. Owners of agistment areas might arrange to handle the milk in bulk, and when conditions improve it should be possible to establish creameries. Stock-owners should form associations for the purpose of finding markets for their produce, the buying of foodstuffs, and the purchase of animals of improved breeds.

There is a local market for milk which should be secured, and an export trade in cattle can be established provided that there is improved breeding, feeding, selection and organization.

Woeful tales are told of the attempts to improve the breed of the cattle by importing stock of improved breeds. Most of the attempts are said to have been disastrous; the imported animals having died within a few months of their importation. Unfortunately, there are no records to show the cause or causes of these deaths. However, it may be taken for granted that imported animals will not live under the conditions which are now common. Imported animal must be carefully managed until they are acclimatised. A short experience of the Colony tends to make one believe that all imported cattle will suffer from the disease Anaplasmosis, transmitted by ticks, when they are exposed to infection on the pastures. Stock recently imported by the Government have suffered from this disease, but experience with the sick animals leads one to believe that this disease in this Colony is not dangerous if the animals are given prompt attention. The land and climate favour stock-raising; there is excellent foundation stock; all that is required to establish a sound profitable cattle industry is action.

MINERALS IN THE PASTURE GRASSES OF BRITISH GUIANA.

BY

R. R. FOLLETT-SMITH, B.Sc., A.R.C.S.

Chemist-Ecologist, British Guiana.

INTRODUCTION.

The principal aim of animal husbandry is the increase of production. Two of the main factors affecting this increase are the improvement in breed and the correct feeding of the stock. Any deficiency or lack of balance in the available feed is likely to be reflected in the stock, in the form of malnutrition and disease.

Until recently the attention of those studying nutritional problems was almost entirely directed towards the balancing of the proteins, carbohydrates and fats, substances which form the main bulk of the food. In some instances it was realised that the mineral contents of the foodstuffs did not meet the demand of the animal body but very little scientific work was done in this direction. Within the last few years it has been generally recognised that a deficiency of inorganic salts or of vitamins, complex organic substances whose presence in very small amounts is necessary to the healthy development of stock, may be the cause of malnutrition or disease.

The subject of the mineral content of pastures in relation to animal nutrition has been considered by Dr. Orr, Director of the Rowett Research Institute. A review of this book appeared in the Agricultural Journal of British Guiana, June 1929, p. 103.

In view of the importance of this subject to stock farmers of the coastal alluvial belt of British Guiana, a number of the principal pasture grasses occurring at the Government Stock Farm, Georgetown, have been examined in regard to their content of minerals. The results of this examination are reported in this paper.

DESCRIPTION OF SAMPLES.

A description of the samples, collected by the Government Veterinary Surgeon, is appended.

(1) *Mixed pasture grass of the Government Stock Farm.* A mixed sample of pasture grasses growing on the Government Stock Farm, Georgetown, the principal constituents of which were :—

Gramineæ	*Paspalum conjugatum* Berg. (Sour grass)
	Panicum laxum Sw. (Bird seed grass)
	Sporobolus indicus R. Br. Prod. (Iron grass)
	Paspalum virgatum L. (Razor grass)
Leguminosæ	*Alysicarpus varginalis* D.C. (Horse weed)
Commelinaceæ	*Commelina nudiflora* L. (Zeb grass)

(2) *Capriola dactylon* Kuntze (Bahama grass) a sample, two months old, collected from the Government Stock Farm.

(3) *Panicum barbinode* Trin. Mem. Ac. (Paragrass). A sample, two months old, collected from the Government Stock Farm.

(4) *Pennisetum purpureum* Schum. (Elephant grass). A sample, two months old, collected from the Experiment Station, Botanic Gardens.

(5) *Commelina nudiflora* L. (Zeb grass). A sample two months old, collected from the Government Stock Farm.

(6) *Asystasia scandens* Hook. (Demerara Primrose). A sample, collected from the Botanic Gardens, Georgetown. A description of the feeding value of this fodder crop appears in this number of the Agricultural Journal (p. 37)

(7) *Uba cane.* A sample of Uba cane stems.

SOILS OF THE AREA.

Examination of soil samples obtained from the vicinity of the Government Stock Farm indicate that the soil is markedly acid (pH 5.5—pH 4.5). It varies in texture from a clay to a heavy silt. The soil possesses a low content of organic matter and is deficient in lime and phosphate. The supplies of potash, however, appear to be adequate.

RESULTS OF ANALYSIS.

The samples of pasture grasses collected were examined as to their content of :—

(a) Total ash.
(b) Silica-free ash.
(c) Chlorine.
(d) Ferric oxide.
(e) Phosphate.
(f) Calcium oxide.
(g) Magnesium oxide.
(h) Potassium oxide.
(i) Sodium oxide.
(j) Nitrogen.

TABLE I.

ANALYSIS OF PASTURE GRASSES—DRY WEIGHT BASIS.

	Total Ash	Silica-free Ash	Chlorine	Ferric Oxide	Phosphate	Calcium Oxide	Magnesium Oxide	Potassium Oxide	Sodium Oxide	Nitrogen
Mixed pasture grass	10.55	4.75	0.56	0.17	0.92	0.30	0.85	1.61	0.99	1.38
Bahama grass *C. dactylon*	8.46	4.12	0.20	0.11	0.22	0.49	0.45	1.38	0.54	1.18
Para grass *P. barbinode*	9.60	5.88	1.56	0.12	0.22	0.25	0.61	2.22	1.36	1.21
Elephant grass *P. purpureum*	12.49	8.18	0.47	0.30	0.03	0.28	0.59	3.85	0.48	0.85
Zeb grass *C. nudiflora*	13.45	8.67	1.92	0.32	0.28	0.93	2.23	3.34	1.11	1.80
Demerara Primrose *A. scandens*	15.89	15.09	3.63	0.08	0.82	0.82	2.34	4.54	3.89	3.83
Uba Cane	2.74	1.82	0.12	0.09	Trace	0.07	0.25	0.86	0.29	0.09
Natural savannah grasses	7.42	1.61	0.05	0.06	0.05	0.16	0.31	0.38	0.36	0.55
British pasture (all grazed)	...	5.85	0.64	...	0.67	0.65	...	2.66	0.37	2.50
Falkland Islands grass	...	4.56	0.74	...	0.54	0.29	...	2.20	0,31	1.95

The results of this examination, stated as percentages of the oven dry weight, are presented in Table I. For comparison the table also shows the mean figures obtained for samples of five natural savannah grasses of the intermediate savannahs of the Colony and the results of analysis of grasses occurring in other parts of the world.

DISCUSSION OF RESULTS.

The results reported for British 'all grazed' pasture may be taken as a standard of comparison.

(a) *Mixed pasture grass.* The content of silica-free ash, a figure by which one may roughly judge the feeding value of a pasture since it represents the total quantity of metabolisable minerals present, is low. In this respect the grass compares with the pasturage of the Falkland Islands, an area where the high mortality among sheep led to an investigation of the mineral content of the pasture grass. This sample of mixed herbage appears to contain adequate supplies of chlorine, iron, phosphate, magnesium and sodium. It is, however, deficient in lime and nitrogen and possesses a low potassium content.

(b) *Bahama grass—C. dactylon.* The sample examined possesses a very low silica-free ash content. It contains adequate supplies of iron, magnesium and sodium. It has a low content of lime and appears to be deficient in chlorine phosphate, potassium and nitrogen.

(c) *Para grass—P. barbinode.* The sample of this grass is comparable to the 'all grazed' British pasture in respect to its content of silica-free ash. There is a marked accumulation of sodium and of chlorine. The grass contains adequate amounts of these elements and of iron, magnesium and potassium. It is, however, deficient in phosphate, lime and nitrogen.

(d) *Elephant grass—P. purpureum.* The sample of Elephant grass examined possesses a relatively high content of silica-free ash. The grass contains adequate supplies of iron, magnesium, potassium and sodium, the accumulation of the two latter elements being marked. This fodder crop appears to be deficient in chlorine and lime and markedly deficient in phosphate and nitrogen.

(e) *Zeb grass—C. nudiflora.* The sample of this grass contains a relatively large amount of silica-free ash. There is a marked accumulation of chlorine, magnesium, potassium and sodium. The supplies of iron and lime appear to be adequate, but the grass is deficient in phosphate and nitrogen.

(f) *Demerara Primrose—A. scandens.* The sample of Demerara Primrose examined possesses a very high content of silica-free ash. There is a very marked accumulation of chlorine, magnesium, potassium, sodium and nitrogen. The content of iron is adequate. The amounts of lime and phosphate are well balanced and compare favourably with those found in the 'all grazed' pastures of Great Britain.

(g) *Uba cane.* The figures here reported refer to the ash composition of Uba cane stalks. They cannot therefore be compared with the other figures, presented in Table I, which indicate the composition of the leaf ash of the grasses.

(h) *Savannah grasses.* The mean values obtained from the examination of ten samples of naturally occurring savannah grasses, representing five varieties, indicate that these grasses have a very low silica-free ash. They are very deficient in every mineral constituent estimated with the possible exception of iron and magnesium.

In general, the samples of pasture grasses of the coastal alluvial belt of British Guiana, which have been examined, appear to contain adequate supplies of iron, magnesium and sodium. They are markedly deficient in nitrogen, lime and phosphate. The potassium and chlorine contents of some of the grasses are low, in other samples, however, there is a marked accumulation of these constituents. Demerara Primrose forms an exception to this general statement, in that it contains adequate supplies of every constituent estimated. Experience of this plant as a stock feed has been described elsewhere and confirms the analytical findings here reported.

The deficiencies of lime and phosphate in the coastal pasturage may be overcome either by the manurial treatment of the soil or by the periodic administration of a ration of bone meal. Applications of ground limestone and of rock phosphate to the soil will tend to improve the lime and phosphate content of the pasture grass ; such a procedure, however, is likely to be more expensive than is the regular feeding of bone meal.

The work of Woodman at Cambridge has shown that young, closely grazed pasture grass is much superior to the best quality meadow hay and compares favourably with a concentrate of the nature in linseed cake in respect of its content of nitrogen and its digestibility. It is probable that the introduction of a system of close grazing upon confined areas in British Guiana would do much to overcome the deficiency of nitrogen indicated in the analyses here reported.

SUMMARY.

A number of samples of different varieties of pasture grasses occurring in the vicinity of the Government Stock Farm have been analysed. The samples examined appeared in most cases, to be deficient in lime, phosphate and nitrogen, nor is this surprising for the soil of the area is lacking in supplies of lime and phosphate, and possesses a low organic matter content. Compared with palatable pastures of Great Britain these samples are ill balanced for, besides the deficiencies mentioned, they contain, in a number of cases, marked accumulations of chlorine, magnesium, potassium and sodium. The deficiencies of lime and phosphate may be overcome by the application to the soil of suitable quantities of ground limestone and rock phosphate. It is probable that the routine administration of bone meal will be a less expensive remedy. The nitrogen status of the

pasture grasses of British Guiana may well be improved by the close grazing at weekly or fortnightly intervals, of confined areas of pasturage.

ACKNOWLEDGEMENT.

The writer wishes to acknowledge indebtedness to his colleague, Mr. C. L. C. Bourne, who, with the assistance of Mr. L. A. Robinson, has been responsible for the majority of the analytical determinations

SELECTED ARTICLE.

SUGAR-CANE MOTH BORERS.*

SOME RECENT WORK ON PARASITES OF THE SMALL MOTH BORERS (*DIATRAEA*) OF SUGAR-CANE.

BY

J. G. MYERS, Sc.D., F.E.S.,

Imperial Bureau of Entomology.

(E.M.B. West Indian Investigation).

Of all the insect pests of sugar-cane the small moth-borers (species of *Diatraea*) are probably the most widely distributed and the most generally injurious. This is decidedly the case in the tropics of the New World, where recent research, on more intensive lines than in the past, tends to emphasise their importance. Some of the most thorough of these investigations have been carried out by the entomologists of the Tropical Plant Research Foundation in Cuba; and there it appears that the injury inflicted by *Diatraea* is increasing year by year. This may quite well also be the case in the British colonies, although in some of them such as British Guiana the usual infestation is so much higher than that hitherto reported for Cuba that there are grounds for the view that it has reached a maximum for the present agricultural and biological conditions. Whether or not this is the case, it is not certain that the considerable work already accomplished on *Diatraea* has in any case produced any appreciable measure of control. It is apparent that far more fundamental investigations are required—intensive and co-ordinated and on a scale commensurate with the magnitude of the industry concerned.

There are two promising lines along which such research might proceed. The first consists in a thorough ecological study such as *Diatraea* has hitherto nowhere received. This is essential if *Diatraea* is to be regarded as a problem to be solved once and for all, rather than as a permanent nuisance to be mitigated by mere *ad hoc* partial methods.

There is one sugar-cane pest, the frog-hopper (*Tomaspis saccharina*) in Trinidad, of which the physical and chemical ecology has been really thoroughly studied, with extremely valuable results. Similar data are urgently required for *Diatraea* and exact numerical observations also on the processes involved in the growing of cane and rice from the point of view of their effect on *Diatraea* and its parasites. Such a study should strenuously avoid mere expressions of opinion, and should base its results on exact quantitative studies of borer infestation and

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of rate of parasitism at various stages in the growth of the crop. Much has been written on the bad effect the burning of fields before cutting is said to exert on the parasites, especially the egg-parasites. This depends largely on the rate of effective parasitism; and no statement made on our present knowledge can be much more than a pious opinion.

Many estates both in British Guiana and in Trinidad regularly employ large gangs to collect borers from young cane. In most cases the resulting catch is counted and straightway destroyed. The effect of this practice on the parasite balance has never been investigated in the British Colonies, nor has its real effect on the infestation been ascertained. Recently, by carefully controlled experients in Cuba, Plank has shown that cutting out of "dead hearts" greatly reduced the percentage of borer parasitism, "and at harvest time it was over 20 per cent. less in the fields from which the dead hearts had been removed than in the adjacent untreated fields." This result of course, needs confirmation in other colonies, but as it stands it gives cause for much thought.

Then again there is the question of weed-grasses. Many of these harbour the borer, but in many, if not all, the rate of parasitism is higher than it is in the cane. Several species of parasites which do not attack the borer in cane, parasitise it in these grasses, the flowers of which, in many cases, are moreover greatly attractive to the adult parasites. This example is given to show the extreme complexity of the problem and the need for studying *Diatraea* not only in the two main crops (cane and rice) which it attacks, but in its wild hosts and original habitats too. So far as the British colonies are concerned such work could well be centred in British Guiana and in Barbados, as representing the two ecological extremes of this region. It is essentially a task for whole-time resident entomologists.

The second promising line of work lies in the direct utilisation of parasites. The needs here are threefold :— firstly to work out in detail the complex interrelations of *Diatraea*—plant-host-parasite, outlined above and to study the effect of the agricultural operations on this balance ; secondly to devise ways and means of assisting artificially the parasites already present ; and thirdly to introduced new parasites. The first and second again fall within the province of the resident research entomologist suggested above. It is with the second and third that I am chiefly concerned here.

In the encouragement of local parasites it is rigidly controlled experiment on a large scale which is needed. It must be emphasised that while the introduction of foreign parasites is a recognized method of biological control, with many overwhelming successes to its credit, the attempted encouragement of indigenous parasites has nowhere been unequivocally successful. The rearing and liberation of native egg-parasites (cheifly *Trichogramma)* on a very large scale is a new development, the application of which is being watched with the greatest interest. Without digressing far into the history of this innovation, we may gather from a collection of recent papers some notion of its progress.

It was Cleare in 1921 who first devised a method for breeding on a large scale the egg-parasites (*Trichogramma* and *Prophanurus*) of *Diatraea*. This method, which is still practised on three or four large estates in British Guiana, most ingeniously utilises the material brought in by the borer gang which most estates in that Colony employ to cut out borer-infested shoots ("dead hearts"). These shoots are stored in the insectary and the moths which emerge produce the eggs which are used to rear *Trichogrammas* for liberation. By this means from one insectary as many as 35,000 egg-parasites have been liberated per day for three months at a time. On the estate where the present writer has recently had an opportunity of studying it in detail an average of 6,000 per day were liberated during 1928.

In California, Flanders desired to utilise *Trichogramma* against the codlin-moth (*Cydia pomonella*). This insect being notoriously hard to rear, it was necessary to find some other host upon which the egg-parasites could be bred in sufficiently large numbers under laboratory conditions, for liberation early in the season. To Flanders belongs the threefold credit of recognising this difficulty and meeting it adequately; of realising the prodigious numbers of parasites which must be liberated if this method is to enjoy any prospect of success; and finally of elaborating a method by which such numbers could be produced with a minimum of labour, time and expense. The essence of Flander's scheme lies in the utilisation of the Angoumois grain moth (*Sitotroga cerealella*) as the laboratory host; and it is sufficient tribute to his ingenuity that later workers have followed his methods almost exactly.

Flanders has calculated that, to control a plant pest by means of *Trichogramma* thus reared, it is necessary to liberate 10,000 for every 100 square yards of leaf surface of the crop to be protected. At his own rearing plant he has aimed at a liberation of one million parasites per day.

The first to apply his methods to *Diatraea* were Hinds and Spencer in Louisiana, in 1927. They claimed certain practical results by liberating *Trichogramma* in large numbers earlier in the season than it normally occurs.

The most recent attempt to use *Trichogramma* against *Diatraea*, and the one which concerns us most here, is that of Tucker in Barbados. In Barbados I am assured by Professor Ballou that it is not the custom to employ borer gangs. There is no readily available supply of borers and the Angoumois grain moth is thus found to be the most convenient laboratory host. On estates where borer gangs are regularly employed, *e.g.*, in Trinidad and in British Guiana, there can be no doubt that the borers themselves are more conveniently utilised, at least for the numbers at present used. By this means on one estate in British Guiana, an average of 6,000 a day are reared by the labour, full time of one boy, and part time of a locally-trained man.

Tucker's scheme has already been described in this journal (Vol. VI. No. 8, July, 1920) and it is only necessary to state here that he is rearing about two

million *Trichogramma* per month, and plans eventually to produce considerably more during periods believed to be critical. The parasites are being distributed to the planters in lots of 12,000 parasitised eggs made up of small paper slips each holding about 50 eggs. It is instructed that one paper should be deposited to every 10 stools of cane, in chessboard fashion. There would thus be 15 slips or 750 parasites per acre.*

It is proposed to treat the whole island of Barbados; so that the experiment is on such a scale that very widespread interest will attach to the results.

It remains to raise a question as to the numbers of liberated parasites necessary for an appreciable measure of control. If Flanders' estimate of the requirement is even remotely correct, it is obvious that not only the Barbados numbers, reared on *Sitotroga*, but also the British Guiana liberations bred on *Diatraea* and very much larger in proportion to the area served, are hopelessly inadequate. So far as *Diatraea* is concerned, data are available which permit us to view the problem from another angle. Throughout British Guiana *Diatraea* infests about 90 per cent. of the stalks of all cane grown, and about 25 per cent. of the joints (Cleare), and this in spite of the fact that *Trichogramma* parasitises the eggs at the rate of at least 35 per cent. (Cleare, 1928, estimates 40 per cent.). This suggests a point I have never seen raised in any discussion of the problem. As in the European corn-borer (*Pyrausta nubilalis*) so in *Diatraea* those influences which Thompson and Parker have aptly named "intrinsic controlling factors" are responsible for a very high mortality among the newly-hatched larvae before they have ever entered the cane-stalk at all. Cleare estimates this mortality at 90 per cent. and my own observations lead me to believe this an under-estimate. In other words the young larvae from at least 90 per cent. of the *Diatraea* eggs will die in any case, whether parasitised or not. This obviously very materially reduces the *effective* work of the egg-parasites, and in fact renders them no more important than the larval parasites. It goes far also to minimise the oft-quoted evil effects of burning the cane-fields before cutting.

It is possible on the above data and with certain theoretical assumptions to make various calculations as to the effective rate of parasitism of *Trichogramma* and as to the number required on a given area, with a given infestation, to raise that rate sufficiently to achieve control. Until, however, more intensive biological studies have been made, on the lines suggested above, I do not believe such calculations could be sufficiently accurate to guide practical work. What is urgently needed in the utilisation of egg-parasites, is a rearing and liberation of at least a million a day, and a concentration of this total on a *small* area where demonstrable, substantial and unequivocal results can be expected. Until then we are working in the dark.

While the first to utilise the *local* parasites of *Diatraea* on a large scale was Cleare, the pioneer of biological control by the introduction of *foreign* parasites in

*In the original publication these figures appear as "150 slips or 7,500 parasites per acre." The correct figures, supplied by the author, are given here.—Ed. Ag. Jl. B.G.

the West Indies was Box, to whose enthusiasm much of the present local interest in this method is due. The success of such introductions must depend firstly on a thorough study of the *Diatraea* and its parasites in the various parts of its range ; and secondly on a judicious selection of parasites to be introduced into regions where they do not naturally occur. In his paper of 1928, Box describes the habits and life-history of one of the most important of these West Indian parasites, the Tachinid Fly, *Lixophaga diatraeae*. It is believed to be larviparous, but this and many other details of the life-history are at present unknown. The known natural range of this fly includes the Greater Antilles except Jamaica. It has been introduced since 1915, into Louisiana, Mexico and British Guiana—apparently with very little success. Box suggests that in the case of all these countries the new conditions were too dissimilar to the original habitat, for speedy success to be achieved. This seems very reasonable as also is his further suggestion that *Lixophaga* be introduced into Barbados, where environment would be more like that of its home. The writer hopes, with the concurrence of the Barbadian authorities, to carry out this proposal during his present mission. Another suggestion of Box may, in view of the proposed inter-island air service, prove a very fertile one namely, the utilisation of aeroplanes for the rapid transport of parasites like the Tachinids which often suffer considerable mortality on long journeys.

The most recent and useful contributions to a survey of known parasites of *Diatraea* are the list by Box (1927,) which includes only American species, and the well-documented catalogue by Van Dine which is world-inclusive. In the introduction to the latter Van Dine makes a plea which may fittingly conclude these notes. He writes : "Our interest in the subject is international. We hope that mutual interests in those countries where sugar-cane moth-borers are a problem will lead to closer co-operation in control by the use of parasites. While the writer favours co-operation in all efforts on explorational work for parasites, it is not considered that joint support and direction of such work is practical. Each region should assume its share of the work, directed to meet its own requirements, and by real co-operation profit by the work of all."

So far as the British colonies are concerned, a very considerable step towards such co-operation has been made by the appointment of the present reviewer to investigate under the auspices of the Empire Marketing Board, the biological control of *Diatraea* and other major pests throughout tropical America.

As a concrete item in such co-operation nothing could be better at the present stage than a uniform method of recording rates of borer infestation and parasitism. In British Guiana, where of the British colonies *Diatraea* has been studied most intensively, it has long been the practice on many estates regularly to record at the time of cutting the percentage of stalks and the percentage of joints bored in every field. A collection of such records from the chief estates of all the British colonies would be of inestimable comparative value and would serve as a check on the effects of parasitic introduction.

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REPORTS.

WEST INDIAN CONFERENCE OF AGRICULTURAL OFFICERS.

On the afternoon of 23rd January, the Hon. S. M. Grier, C.M.G., Acting Governor of Trinidad, opened the West Indian Conference of Agricultural Officers which was held under the Chairmanship of the Principal at the Imperial College of Tropical Agriculture. This Conference which sat for six days was officially attended by the Commissioner and Assistant Commissioner of the College Advisory Department of Agriculture, nine delegates from the several Colonies represented which included British Guiana, Trinidad, Barbados, Bermuda, the Leeward and Windward Islands, seven members of the Professorial Staff of the College, and the Editor-Librarian, who acted as Secretary. His Excellency in welcoming the delegates stressed the importance and potential value of the Conference whose primary objective was to bring together agricultural representatives from the various parts of the West Indies for the purpose of co-ordinating the work which they were doing. Mr. Evans, Principal of the College, prefaced his address by a statement on the origin of the Conference and by two messages of good wishes received from Lord Passfield and Sir Edward Davson, which both emphasised the need for co-operation. The Principal then dwelt at some length on the specific functions of the College and outlined the programme of the Conference. The Hon. J. S. Dash, Director of Agriculture, British Guiana, thanked His Excellency for the address of welcome and Mr. Evans for the excellent arrangements that had been made in connection with the organisation of the Conference. On the afternoon of the same day a Garden Party was given in honour of the delegates by Mr. and Mrs. Evans.

On the following day the subject of the Canadian trade in fruit and produce was fully discussed. Mr. J. A. McBride, General Manager of the Fruit Importers Ltd.; Canada, and Mr. F. E. Holloway, President of the Mutual Brokers, Montreal Ltd., had been invited to join in the discussion and gave much valuable information on the development of this trade in Canada. On 25th January, Mr. F. Hardy, Professor of Chemistry and Soil Science, opened a discussion on "Soil Research" by delivering an address on the development of this line of research in the West Indies On the following day experimental programmes were discussed and Mr. C. Y. Shephard, Professor of Economics, read a paper on "Agricultural Economics." On 28th January, Mr. E. E. Cheesman, Professor of Botany and Genetics, introduced the subject of cane variety problems of the West Indian regions. As a result of these papers and discussions a number of findings were framed which will in due course be published in the Proceedings of the Confer-

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ence. The last day of the Conference was devoted mainly to the consideration of the reports and recommendations submitted by the Sub-Committees. The first of these Sub-Committees was appointed under the Chairmanship of Mr. H. A. Ballou, Commissioner of Agriculture for the West Indies, to examine quarantine rules and regulations, and the second, under the Chairmanship of the Hon. J. S. Dash, to consider the standardisation of the lay-out of field experiments.

As it was not possible, owing to lack of time, for the delegates to submit suggestions for items to be considered at the Imperial Agricultural Research Conference to be held in 1932, it was decided to forward the Secretary of State's letter asking for this information to the delegates for consideration. Other questions discussed were the formation of a Permanent Conference Committee and the date of the next Conference. A very appreciative vote of thanks by the visiting delegates to the Governors and Staff of the College, the Chairman, the Director and Staff of the Trinidad Department of Agriculture and to the Secretary concluded the Proceedings of the Conference.

A number of excursions were arranged. The delegates first visited the Government Stock Farm where they were given the opportunity of discussing problems of cattle breeding in the tropics with Captain H. V. Metivier. On 26th January, which was a Sunday, the Headquarters of the Trinidad Department of Agriculture at St. Clair, were inspected on the way to the Department's Experimental Station at River Estate where, after a most instructive morning, the delegates were the guests at lunch of the Director of Agriculture. A visit was paid to the Cotton Station on 27th January, the party being shown round by Drs. S. C. Harland and E. J. Maskell and Mr. J. B. Hutchinson.

Finally on 28th January, an excursion, arranged through the courtesy of Captain W. F. Watson was made to the Waterloo Estates, where it was possible to inspect the large scale series of lime and fertilizer trials that had been designed on the most up to date lines, with the object of testing out in the field the recommendations made by the Scientific Committee of the Froghopper Investigation Committee. A demonstration of mechanical tillage methods followed and on the way to Exchange House, where the delegates enjoyed the hospitality of Mrs. Watson, a visit was made to the Model Dairy.

On the 25th January all official delegates were entertained to dinner at Government House by His Excellency the Acting Governor and Mrs. S. M. Grier. Another dinner was given in their Honour by the College Amalgamated Clubs on 27th January in the College Dining Hall. Both these functions were much appreciated.

PROGRESS REPORT.

BUSH LOT LAND SETTLEMENT, ESSEQUEBO.

The establishment of a Land Settlement Scheme at Bush Lot, Essequebo,—a District devoted principally to rice cultivation—has received, for some time past, the close and careful consideration of the Colonization Committee with the object of commencing settlement by the 1st January, 1930. This, however, did not prove practicable, but every effort is being made to effect settlement by the 1st April next. Rice land has been prepared and is ready for planting out; attractive and substantial houses have been erected and are awaiting occupation; good irrigation water is available and satisfactory drainage has been established. All that now remains is for suitable settlers to come forward and participate in the Scheme.

To assist in the selection of settlers, the help of the Immigration Department has been enlisted and notices in Hindi and Urdu setting out, as a general guide, the terms and conditions which have been drawn up to apply to the Settlement until legislation is passed, have been issued and have been widely circulated by Immigration Agents in the various districts, and by the Settlement Officer in Essequebo. These notices have also been posted up at principal Police Stations, Post Offices, Steamer Stellings and Railway Stations throughout the Colony. The abovementioned officers have further been authorised to accept applications from suitable East Indians in any part of the Colony who may desire to settle and they have also been placed in a position to answer questions relating to the Scheme.

The new Deputy Director of Agriculture who recently arrived in the Colony has been co-opted by the Committee and his services will be of great assistance in helping to facilitate the settling of the requisite number of East Indian families, which it has been decided to limit to 85 families instead of 100, purely for convenience of settling. This Officer, who has had previous experience in Ceylon, will advise the Committee as regards running the Settlement on co-operative lines and establishing suitable markets for the produce obtained from the Settlement. The terms and conditions relating to the Settlement are given below. If these prove to be unworkable they will be revised; the whole idea being to have a happy and contented Settlement, resulting in increased production and with the final object of attracting suitable immigrants from other countries to the Colony.

The Committee hopes that it will be appreciated that there is now offered to East Indians in the Colony who are keen on rice farming on a systematic scale under proper supervision and advantageous conditions, a splendid opportunity which should not be missed. It is a well known fact that there are several persons in the community who are not "pulling their weight," but it is hoped that those

East Indians who are interested in the Colony's welfare and are prepared to make a good living under ideal conditions, will come forward and join the Settlement. It is hardly necessary to emphasize how desirable it is that the first Settlement should be a success from every point of view.

In conclusion, it should be stated that the Colonization Committee hopes later to consider a land settlement scheme suitable for the settlement of persons of African descent. As Bush Lot will be a Rice Settlement, the settlers are therefore being selected from East Indian families now resident in the Colony.

TERMS AND CONDITIONS.

1. Each family will be allotted at first three acres of well irrigated and drained rice land. Extra land will be available to tenants proving themselves capable of efficiently working additional lots.

2. The period of rental, in the first instance, will be for a term of three years to enable the suitability or otherwise for permanent occupancy to be ascertained.

3. During the three-year period of rental the following charges will be made:—

(a) Annual land charge—$7 an acre made up as follows —

Rent	$ 4.00
Maintenance	2.00
Drainage Board Assessment	1.00
	$ 7.00

(b) Annual rental for house and house plot,

(c) Annual pasturage charge per head of cattle, $2.88

(d) Annual sanitation rates, 75 cents.

4. The purchase price of the property at the commencement is fixed at $600, and when the three-year period of rental is about to expire, a tenant, if having shown proof of his ability to make full economic use of his land, may apply for, and will receive, the right to purchase his house, house plot and farm for a sum of $500, being the approximate value of the property less the amount paid in rent during the three-year period of tenancy, on the following terms:—

(a) Purchase price must be for whole property and not for house plot or cultivation alone.

(b) Payment may be made in full or spread over a period of 12 years with interest at the rate of 6% per annum, plus maintenance rate ($2) and drainage board assessment ($1) which will be a perpetual charge.

(c) Amount payable in rent for the first three years can be deducted from the total purchase price of the property.

5. No settler will be allowed to purchase his farm and house outright until he has been on the settlement for three years as a renter.

6. Any family joining the settlement after April 1, 1930, will commence the period of rental from the date of joining the settlement.

7. Repairs to houses will be borne half by the settler and half by Government.

8. Restrictions against alienation of land and property, leasing and mortgaging (except to an Agricultural Bank or Co-operative Society), and testamentary or intestate succesion will be imposed and rigidly enforced, and will be drawn up, during the period the first batch of settlers are renters.

9. If a settler has not proved satisfactory after three years as a renter he will be called upon to vacate the settlement.

10. If a settler becomes objectionable in his behaviour, or is convicted of any serious criminal offence, he is liable to be ejected from the settlement.

11. Tenants and owners will be required to make punctual payment of rents, rates, and purchase money on penalty of deprivation of their rights to the land and buildings.

12. A rice mill will be operated near the settlement for the benefit of the settlers and will be run on co-operative lines, if a sufficient number require it. The Agricultural and Settlement Officers will be available to supervise and assist settlers in all matters appertaining to the cultivation and handling of their crops and stock.

H. HAYDOCK WILSON,
SECRETARY, COLONIZATION COMMITTEE

11th February, 1930.

DEPARTMENTAL NEWS.

Professor the Honourable J. Sydney Dash, Director of Agriculture, attended the Conference of Directors of Agriculture held at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, as representative of British Guiana, and was absent from the Colony from January 21 to February 2.

Consequent on the absence from the Colony of Professor the Honourable John Sydney Dash. B.S.A., Director of Agriculture, His Excellency the Officer Administering the Government appointed Mr. L. D. Cleare, Jnr., F.L.S., F.E.S., to act as Director of Agriculture as from January 22, until the arrival in the Colony of the Deputy Director of Agriculture.

Mr. F. Burnett, M.C., M.A. (Oxon)., Deputy Director of Agriculture, arrived in the Colony on 27th January and assumed duty. Mr. Burnett was Agricultural Officer in charge of the Central Province of Ceylon from 1926 to 1930. He was chairman or vice-chairman of a number of Agricultural Committees of this District and a member of the Board of Agriculture and Food Production Committee, as well as Assistant Registrar of Agricultural Co-operative Credit Societies from 1921—1930. In addition to his other duties, he was Vice-Principal of the School of Tropical Agriculture from 1926 to 1930. Mr. Burnett was, prior to this, Agricultural Officer of the Southern Province, Ceylon (1921—25), and has had ranching experience in Argentine from 1911 to 1914.

Mr. J. A. Gillespie, B. Sc. (Edin.), arrived in the Colony on January 27, and assumed his duties as Agricultural Superintendent. Mr. Gillespie has had previous experience in Egypt from 1926—1929 in connexion with the Cotton and Rice industries of that country. Mr. Gillespie will be stationed on the West Coast, Demerara.

Mr. Hector Macluskie, U.D.A. (Aberdeen), arrived in the Colony on February 3, and assumed duties as Agricultural Superintendent. Mr. Macluskie has recently taken a refresher course at the Imperial College of Tropical Agriculture, and prior to this was for some years engaged in agriculture in England. For four years he was in the Argentine and was engaged in irrigation and fruit farming with the Agricultural Department of the Great Southern Railway. Mr. Macluskie will be stationed in Berbice.

Mr. E. M. Morgan, Resident Agricultural Instructor, Berbice, has been granted six months' leave of absence as from January 1.

Consequent on the absence of Mr. Morgan, Mr. H. D. Huggins, Assistant Agricultural Superintendent has been transferred temporarily to the Berbice District.

In September last Mr. E. B. Martyn, Botanist and Mycologist, again visited the N.W.D. in connection with the Sclerotium disease of coffee. In October he spent a short time with the Oxford University Scientific Expedition. More recently visits have been paid to several estates.

The Chemist Ecologist, Mr. R. R. Follett-Smith, visited Pln. Uitvlugt on December 21—23, 1929, for the purposes of inspecting soils and collecting samples, and Pln. Leonora on February 4—6, 1930.

Mr. H. H. Wilson, Secretary, Committee and Acting Senior Clerk of this Department has been granted six months' leave of absence as from March 7.

Mr. J. F. Irving, M. C., resumed duty as Senior Clerk in the Department and Secretary, Colonization Committee as from March 7.

. Mr. L. D. Cleare, Government Entomologist, will be proceeding on leave to England shortly. On the inception of this Journal Mr. Cleare undertook the preparation of the cover design and general lay-out of the publication, and since then the editorial duties have been performed almost entirely by him With this and the previous number Mr J. A. V. Bourne has assisted.

PLANT AND SEED IMPORTATIONS.

THE FOLLOWING ARE RECENT INTRODUCTIONS BY THE DEPARTMENT OF AGRICULTURE.

DESCRIPTION	QUANTITY	WHENCE RECEIVED
Economic.		
Pineapple "Red Spanish"	60 Suckers	Department of Agriculture, Trinidad.
Avocado Pears, Budded,		
"St. Anns"	6 Plants	„
"River"	2 „	„
"Rudder"	2 „	„
"Pollock"	1 Plant	„
"St. Clair"	1 „	„
Grafted Mangoes "Gordon"	3 Plants	„
"Graham"	3 „	„
"Julie"	3 „	„
"Pierre Louis"	3 „	„
Sour Orange Seeds	7,000	„
Beet seed	3 lbs.	Messrs. Peter Henderson, New York
Rice Padi "Blue Rose"	2 Bags	Mount Royal Rice Mills, Ltd., Montreal.
"Carolina Edith"	2 „	
"No. 36"	Small quantities	Empire Marketing Board
"No. 11"		
"Kalyaman"		
"Americano 1600"	do.	Italy
Guatemala Grass	42 cuttings	Trinidad
Canavalia Gladiata (Purple seeds)	Small quantities	„
Cauliflower		„
Beans—4 varieties		„
Sugar Cane, P.O.J. 2878	12 cuttings	„
Desmodium tortuosum	2 lbs.	„
Stizolobium sp.—4 species		
70923	5 ozs.	„
46448	11 ozs.	„
Yokohama	5.75 ozs.	„
Arlington	9 oz.	„
Ornamental.		
African Succulent Plants	12 Kinds	University of Stellenbosch, South Africa.
Agapanthus umbellatus	3 Bulbs	Director, Botanic Gardens Lithuania.
Palms—Daemonorops angustifolius	12 Seeds	Botanic Gardens, Singapore
Olania philippinensis	4 „	do.
Oncosperma horrida	10 „	Straits Settlements.
Ptychosraphis singaporensis	34 „	do.

EXPORTS OF AGRICULTURAL AND FOREST PRODUCTS.

Below will be found a list of the Agricultural and Forest Products of the Colony exported during 1929.

The corresponding figures for the same period during previous years and the average for the eleven years prior to that are added for convenience of comparison.

Product		*Average 1907-26*	*1927*	*1928*	*1929*
Sugar	tons	97,289	109,616	114,687	100.449
Rum	proof gallons	2,339,289	1,081,120	1,269,923	1,109,482
Molasses	gallons	327,531	2,677,457	2,873,468	2,536,623
Molascuit	tons	3,820	977	2,082	1,803
Rice	tons	6,296	11,497	18,083	14,091
Coconuts	thousands	1,623	334	322	638
Coconut Oil	gallons	22,494	25,326	26,244	20,862
Copra	cwts.	4,745	23,266	70,017	75,187
Coffee	cwts.	3,284	3,844	8,212	8,098
Lime Juice Concentrated	gallons*	9,588	5,249	8,124	12,717
Essential Oil of Limes	gallons*	355	273	440	801
Rubber	cwts.	78	347	143	15
Balata	cwts.	10,286	6,698	5,782	5,356
Gums	lbs.	2,626	640	1,674	707
Firewood—Walaba, etc.	tons	7,897	9,460	10,054	9,369
Charcoal	bags	56,686	40,715	46,374	51,593
Railway sleepers	No.	12,263	18,756	18,873	13,591
Shingles	Thousands	2,259	1,630	2,156	2,424
Lumber	ft.	217,528	263,988	195,773	117,802
Timber	cu. ft.	187,678	215,204	134,044	435,888
Cattle	Head	605	4	503	966
Hides	No.	5,616	6,692	7,146	7,312
Pigs	No.	688	560	457	385
Sheep	No.	58	1	2	None

*An average of eleven years 1916 to 1926.

No records available prior to 1916.

CURRENT PRICES OF COLONIAL PRODUCE.

From The Commercial Review, Journal of the Georgetown Chamber of Commerce, Vol. XIII, No. 8, February, 1930.

SUGAR.

Per 100 lbs. net   3 lbs. per Bag allowed for tare

Dark Crystals for Local Consumption..................$2.60
Yellow Crystals do. do. $3.50
White Crystals..$3.60
Molasses Sugar...... ....none offering

RUM.

Imperial Gallon.   Cask included.

Coloured, in Puncheons—40 to 42 O.P...(for export).....60c. Hhds. 65c. Barrels 70c.
White, in Hogsheads—10 to 45 O.P....(for local consumption)............48 to 50c.

MOLASSES.

Per Imperial Gallon.   Cask included.

Yellow (firsts).. }
Yellow (seconds).. } None Offering
Dark.. }

RICE.

Rice............per Bag of 180 lbs. gross, $3.80 to $5.00 as to quality.
Paddy..........per Bag of 143 lbs. gross, $1.32 to $1.50

GENERAL.

Timber, Gr. Heart, (Lower grade measurements)...72c. to 96c. per c. ft., for export $1.00 to $1.20 per c. ft.
Do. Railroad Sleepers—(Mora)..$1.68 each
Greenheart Lumber....... ....$110 per 1,000 feet
Crabwood Lumber ....$60 to $75 per 1,000 feet
Shingles, Wallaba, 4 x 20 and 5 x 22 inches,.......................$7.00 to $9.00 per M.
Charcoal, Capped for shipment ....$1.00 to $1.20 per Bag
Firewood ....$3.00 to $3.50 per ton
Coconuts ....Selects, $18.00, culls......$10.00 M ....Copra, 3½c. per lb.
Balata... ....Venezuelan, none. Local Sheet...38 to 40 cts. per lb.
Cocoa......... .... 20c. " "
Coffee...8c. " "

N.B.—Duty payable on value at time of Importation and at Rate of Exchange on day of arrival.

METEOROLOGICAL DATA 1929.

BOTANIC GARDENS, GEORGETOWN

1929. MONTHS.	Rainfall	Number of Days of Rain						Evaporation
	Inches.	Under 10 in	10 to 50 in	50 to 1.00 in	1.00 to 2.00 in	Above 2.00 in	Total Days	Inches
January	2.23	7	9	...	...	...	16	4.79
February	5.58	2	5	3	2	...	12	4.90
March	3.63	7	4	...	...	1	12	6.05
April	7.79	6	9	3	1	1	20	5.26
May	10.66	9	11	3	4	...	27	4.34
June	14.59	4	11	3	4	2	24	3.45
July	7.68	7	14	6	...	...	27	3.78
August	5.67	6	4	3	1	..	14	6.01
September	2.64	2	5	...	1	...	8	6.16
October	.58	3	2	...	...	...	5	7.02
November	5.89	5	7	4	1	...	17	5.20
December	4.68	5	6	2	1	...	14	5.02
TOTALS.	71.62	63	87	27	15	4	196	61.98

AIR TEMPERATURE AND HUMIDITY IN THE SHADE BOTANIC GARDENS, GEORGETOWN, 1929.

Months.	Air Temperature.			Humidity.
	Maximum.	Minimum.	Mean.	Mean.
January ...	83.4	74.4	78.9	77.1
February ..	83.4	74.7	79.0	78.6
March ...	84.0	75.4	79 7	78.3
April ...	84.1	76.3	80.2	81.2
May ...	84.1	76.1	80 1	84.0
June ...	83 8	75.1	79.4	85.5
July ..	84.4	74.9	79.6	83.7
August ...	86.0	75.4	80.7	81.6
September ...	87 0	75.9	81.4	80.4
October ...	88.1	75.8	81.9	78.7
November ...	86 3	76.2	81.2	80.7
December ...	84.2	75.2	79.7	80.1
Mean ...	84.9	75.4	80.1	80.8

WETTEST AND HOTTEST DAYS AT VARIOUS STATIONS.

Stations.	Wettest Day.	Rainfall Inches.	Hottest Day.	Temperature. in shade
Botanic Gardens, Georgetown ...	26th March.	2.43	18th Oct.	90.0°
New Amsterdam Public Gardens ...	8th Sept.	4.35	24th Aug.	98.0°
Onderneeming, Essequibo ...	23rd Dec.	4.10	13th, 20th, 22nd and 23rd, September.	93.0°
Morawhanna, N.W.D.	28th June	4.10	...	...

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In collaboration with the Officers of the Department of Agriculture.

CONTENTS.

(Vol. III, No. 2.)

LIST OF ILLUSTRATIONS.

ORIGINAL ARTICLES.

A SOIL SURVEY OF SOPHIA EXPERIMENT STATION

BY

R. R. FOLLETT-SMITH, B.Sc., A.R.C.S.

Chemist-Ecologist, British Guiana.

INTRODUCTION.

A survey of the soils occurring at the British Guiana Sugar Producers' Experiment Station, Sophia, has been undertaken. The objects of the survey were to define the soil types of the station and to investigate the plant nutrient status of these soils. A subsidiary investigation of the effect upon the soil reaction of the system of underground drainage, advocated by Dr. Whittles, has also been carried out.

Forty-six samples of the soil (first foot) and subsoil (second foot) occurring at the station, were obtained by the Field Assistant, L. A. Forte, who followed a sampling scheme suggested by myself.

DESCRIPTION OF SAMPLING PROGRAMME.

The location of the various sampling points may be seen upon reference to the reaction map (map No. 1). Soil and subsoil samples were obtained from seventeen staggered points in the cultivated area of the station, while samples were also taken from three spaced positions in the reserve area not in cultivation. Samples were taken to a depth of four feet from the centre of fields Nos. 2, 10 and 16.

EXAMINATION OF SAMPLES.

The samples obtained were examined as to their reaction by means of the quinhydrone electrode and these results were checked by means of Comber's reagent. The figures, representing the reaction values of soil suspensions (a) in distilled water and (b) in saturated potassium chloride solution, appear in Table I attached.

Information as to the texture of the soils was obtained by means of a partial mechanical analysis [1] involving—

(1) The estimation of the moisture content, at the point of stickiness, of portions of soil kneaded with water until the wet mass just did not adhere to the hands.

HARDY, F., An Index of Soil Texture, J. Agr., Sci., (1928) XVIII p.p. 252-256.

(2) The determination, by sedimentation methods, of the percentage of soil particles having a diameter between 1 mm. and 0.04 mm. (The percentage coarse and fine sand particles which settle in 75 seconds from the 7.5 c.m. level).

From these two determinations a single value constant *the index of texture*, indicative of the texture of the soil, may be obtained by calculation.

The results of a textural examination of the soils are presented in Table II.

The results obtained are also presented graphically in Map I (soil reaction map) and in Map II (soil texture map).

Examination of Map I (soil reaction map) shows that, of the twenty samples of topsoil obtained, sixteen are markedly acid (pH 4.5-pH 5.5) while the remaining four are acid (pH 5.5-pH 6.5). In general the subsoil is less acid than the corresponding topsoil and samples taken to a depth of four feet indicate that the soil becomes progressively less acid with increasing depth.

The soil occurring in fields to the north of field No. 14 is a heavy silt overlying a clay subsoil. To the south of field No. 13 the soil is definitely lighter and both soil and subsoil consist of a fine silt.

The individual samples have been collected into thirteen composite samples having regard to their texture and reaction. The segregation of samples is indicated in Table III.

Lime requirement determinations have been made upon these composite samples and the results appear in Table IV. The lime requirement of the station topsoil varies between four and six and a half tons of ground lime-stone per acre.

The composite samples have been examined as to their content of organic matter. A cane soil, deficient in organic matter, usually contains less than 1.2 per cent. of that constituent. The topsoils of the station vary in their content of organic matter from 1.08 per cent. to 1.62 per cent. They possess, therefore, a low content of organic matter.

Table IV also contains data regarding the amount of 'available' phosphate and potash yielded by the soils to a one per cent. citric acid solution. Examination indicates that the supply of potash is adequate to the needs of the cane, the soils, however, appear to be deficient in 'available' phosphate.

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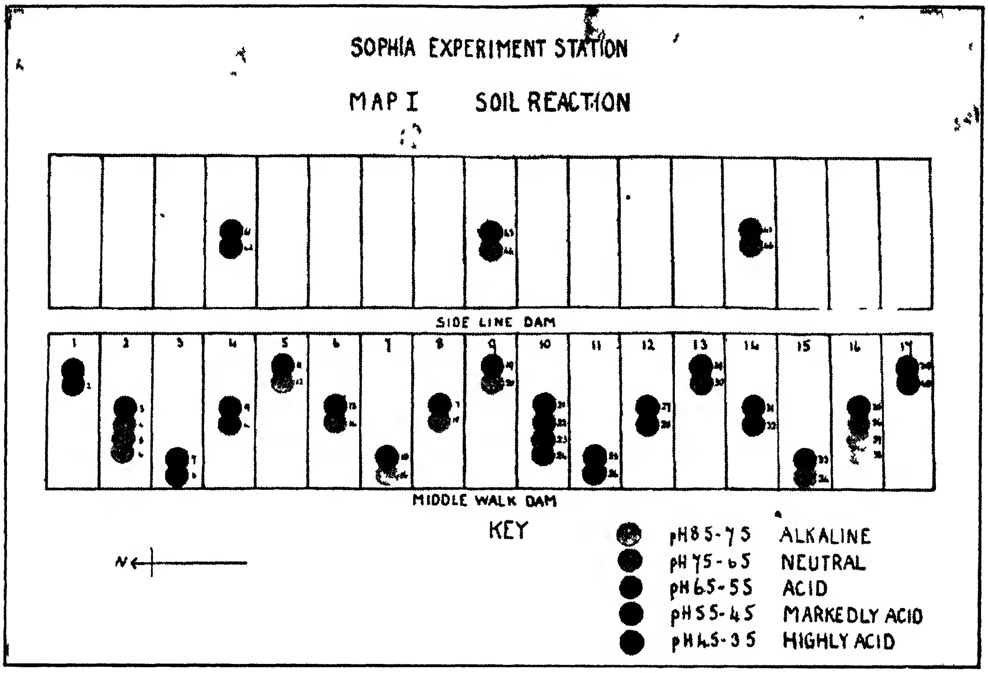
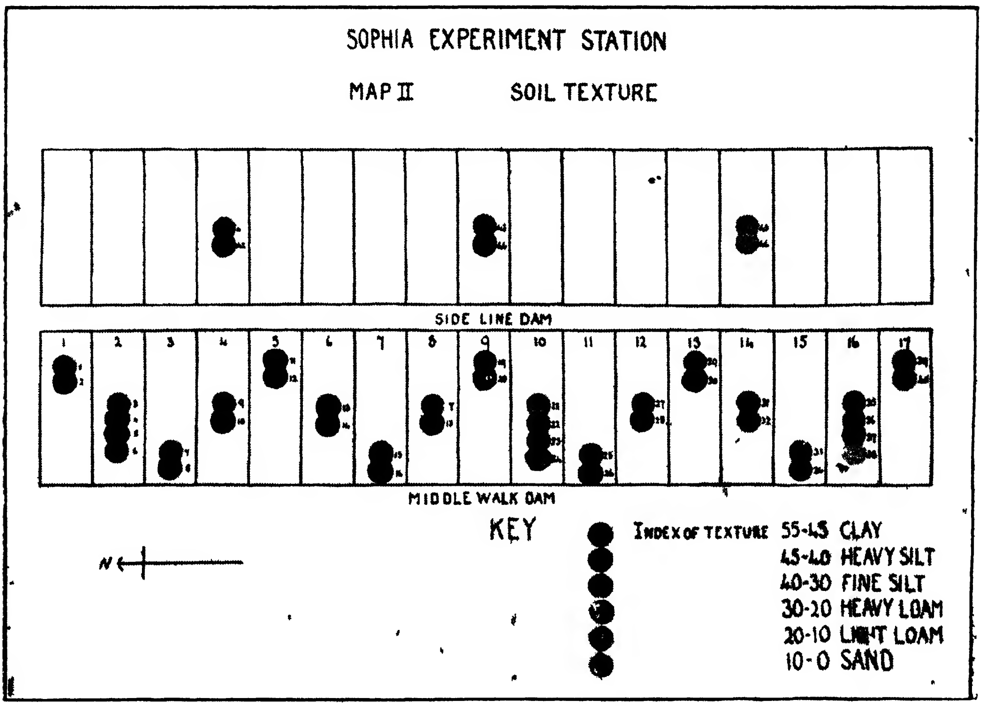
[2] Index of texture=Moisture content at Point of Stickiness Minus $\frac{\%\ \text{Sand.}}{5}$


SOPHIA EXPERIMENT STATION
MAP I SOIL REACTION
SIDE LINE DAM
MIDDLE WALK DAM
KEY
N
pH 8.5-7.5 ALKALINE
pH 7.5-6.5 NEUTRAL
pH 6.5-5.5 ACID
pH 5.5-4.5 MARKEDLY ACID
pH 4.5-3.5 HIGHLY ACID


SOPHIA EXPERIMENT STATION
MAP II SOIL TEXTURE
SIDE LINE DAM
MIDDLE WALK DAM
KEY
N
INDEX OF TEXTURE 55-45 CLAY
45-40 HEAVY SILT
40-30 FINE SILT
30-20 HEAVY LOAM
20-10 LIGHT LOAM
10-0 SAND

EFFECT OF UNDERGROUND DRAINAGE UPON SOIL REACTION.

*During the year 1925 a system of underground drainage was laid out on three beds of Field 12W. The original open-face drains were suppressed and new drains, eighteen inches deep and eighteen inches wide, were first dug 12ft. apart along the middle of the original beds and parallel to the former drains. In the centre of the bottom of these drains a further excavation, six inches wide and eighteen inches deep, was made. On the shoulders thus formed a matting of bamboo laths was placed and the excavated soil was returned and packed down. It was suggested that such an arrangement would facilitate mechanical tillage and improve drainage. Due to depletion of staff the experiment appears to have received little attention during the years 1927 and 1928.

In 1928 the plot appeared to be waterlogged and the underground drains, when examined, were found to be blocked at several points where the bamboo matting had decayed. To relieve the situation the original open-face drains were re-opened. The waterlogged conditions still persisted in 1929 and eventually bed drills, twenty-four inches deep and twelve inches wide, were made on every other bank at right angles to the open-face drains. At the bottom of the drills, whole bamboos, some twelve feet in length, were placed and covered with trash to a depth of twelve inches. The remaining twelve inches were refilled with the excavated earth. This modification of the original idea (suggested by Mr. Cameron) appears to function satisfactorily.

In order to investigate the effect of the original system of underground drainage upon the soil reaction, seven topsoil samples with their corresponding subsoil samples, were withdrawn from the closed drain area, while ten topsoil samples, with their corresponding subsoil samples, were obtained from the adjacent open-drain area. These samples were examined as to their normal and exchange reactions. The mean values are presented in Table V.

The small differences in soil reaction, recorded in Table V. cannot be regarded as significant. Underground drainage, carried on upon the lines originally suggested, appears to have had little effect upon the soil reaction and experience shows that the drains become blocked after a period of three years.

Another field has recently been laid out with closed drains constructed upon the modified system already described (i.e., drains twenty-four inches deep, the lower halves of which are filled with whole bamboos and trash). Water table measurements are being carried out in this area by the Agronomist and it is proposed to carry out soil reaction studies at some future date.

* I am indebted to the Field Manager for this description of the experiment.

SUMMARY.

The soils of the Sugar Producers' Experiment Station have been sampled and have been submitted to textural and reaction examination. Tables and plans are submitted showing the soil variations. The individual samples have been grouped into composites and these have been studied with regard to their theoretical lime requirement, their content of organic matter, 'available' potash and 'available' phosphate. In general, the soil of the station is a markedly acid heavy silt. The soil of the four southernmost fields of the station is lighter and may be classified as a markedly acid fine silt. The subsoil is usually less acid and heavier in texture. The topsoil of the station possesses a lime requirement varying from four tons per acre to six and a half tons per acre. The organic matter content is low and the soil appears to be deficient in 'available' phosphate. It is proposed, with the co-operation of the Agronomist, to lay out field experiments designed to indicate the magnitude of the economic application of these constituents.

An experiment, carried out upon the the soils of Field No. 12W, indicates that underground drains, constructed to the design originally suggested, have had little effect upon the soil reaction.

TABLE I.

SOIL SURVEY, SOPHIA EXPERIMENT STATION.

REACTION DATA

		Normal reaction (distilled water suspension)	Exchange reaction (saturated potassium chloride suspension)
D 1	Topsoil	5.17	4.77 markedly acid
2	Subsoil	4.90	4.70 " "
3	Topsoil	5.45	5.02 " "
4	Subsoil	6.75	6.00 neutral
5	"	6.55	5.93 "
6	"	6.90	6.25 "
7	Topsoil	5.30	4.78 markedly acid
8	Subsoil	5.78	5.28 acid
9	Topsoil	4.97	4.80 markedly acid
10	Subsoil	5.00	4.83 " "
11	Topsoil	5.20	4.58 " "
12	Subsoil	6.65	5.88 neutral
13	Topsoil	5.22	4.82 markedly acid
14	Subsoil	6.88	6.07 neutral

		Normal reaction (distilled water suspension)	Exchange reaction (saturated potassium chloride suspension)
15	Topsoil	5.43	5.10 markedly acid
16	Subsoil	7.75	6.60 alkaline
17	Topsoil	5.27	4.87 markedly acid
18	Subsoil	6.83	5.97 neutral
19	Topsoil	5.62	5.00 acid
20	Subsoil	7.27	6.51 neutral
21	Topsoil	5.22	4.88 markedly acid
22	Subsoil	5.75	5.40 acid
23	„	7.26	6.71 neutral
24	„	6.85	6.39 „
25	Topsoil	5.30	4.53 markedly acid
26	Subsoil	5.78	5.45 acid
27	Topsoil	5.32	4.88 markedly acid
28	Subsoil	6.10	5.38 acid
29	Topsoil	5.17	4.67 markedly acid
30	Subsoil	6.10	5.38 acid
31	Topsoil	5.48	4.85 markedly acid
32	Subsoil	6.25	5.70 acid
33	Topsoil	5.53	4.85 „
34	Subsoil	6.60	5.62 neutral
35	Topsoil	5.38	4.88 markedly acid
36	Subsoil	7.00	6.32 neutral
37	„	7.80	6.83 alkaline
38	„	8.27	7.88 „
39	Topsoil	5.30	5.00 markedly acid
40	Subsoil	5.05	4.45 „ „
41	Topsoil	4.78	4.62 „ „
42	Subsoil	5.25	4.95 „ „
43	Topsoil	5.57	4.92 acid
44	Subsoil	6.68	5.85 neutral
45	Topsoil	5.73	5.43 acid
46	Subsoil	6.50	6.00 neutral

TABLE II.

SOPHIA EXPERIMENT STATION

TEXTURE DATA

		MPS	% Sand	Index of texture	
D 1	Topsoil	47.2	26.3	42	Heavy silt
2	Subsoil	48.6	16.5	45	Clay
3	Topsoil	44.7	14.7	42	Heavy silt
4	Subsoil	49.3	14.4	46	Clay
5	„	47.3	5.7	46	„
6	„	45.9	9.6	44	Heavy silt
7	Topsoil	44.3	7.7	43	„ „
8	Subsoil	47.4	6.3	46	Clay
9	Topsoil	42.4	7.7	41	Heavy silt
10	Subsoil	48.9	6.1	48	Clay
11	Topsoil	49.7	11.0	48	„
12	Subsoil	47.7	5.6	47	„
13	Topsoil	46.5	6.5	45	„
14	Subsoil	48.8	8.5	48	„
15	Topsoil	49.2	5.0	48	„
16	Subsoil	46.6	4.4	46	„
17	Topsoil	44.5	6.5	43	Heavy silt
18	Subsoil	49.9	5.0	49	Clay
19	Topsoil	44.1	8.4	42	Heavy silt
20	Subsoil	46.1	8.2	45	Clay
21	Topsoil	42.0	12.2	39	Fine silt
22	Subsoil	45.8	8.0	44	Heavy silt
23	„	43.3	16.2	40	„ „
24	„	53.4	11.2	51	Clay
25	Topsoil	46.0	7.2	44	Heavy silt
26	Subsoil	48.8	8.2	47	Clay
27	Topsoil	44.0	8.5	42	Heavy silt
28	Subsoil	50.1	6.7	49	Clay
29	Topsoil	44.8	11.7	43	Heavy silt
30	Subsoil	50.5	6.7	49	Clay
31	Topsoil	42.8	18.2	39	Fine silt
32	Subsoil	41.4	26.2	36	„ „
33	Topsoil	38.2	23.7	34	„ „

34 Subsoil	39.0	27.7	34 Fine silt
35 Topsoil	44.1	30.7	38 „ „
36 Subsoil	44.6	34.0	38 „ „
37 „	37.7	33.0	31 „ „
38 „	31.2	18.0	28 Heavy loam
39 Topsoil	37.7	27.7	32 Fine silt
40 Subsoil	42.3	21.0	38 „ „
41 Topsoil	45.1	11.4	43 Heavy silt
42 Subsoil	49.6	7.7	48 Clay
43 Topsoil	45.2	11.0	43 Heavy silt
44 Subsoil	47.7	10.2	46 Clay
45 Topsoil	36.1	22.2	32 Fine silt
46 Subsoil	37.7	37.0	30 „ „

TABLE III

SOPHIA EXPERIMENT STATION

COMPOSITE SAMPLES

TOPSOILS.

DCP I	Markedly acid clays	D	11,13,15
DCP II	Acid heavy silts	D	19,43
DCP III	Markedly acid heavy silts	D	1,3,7,9,17,25,27,29,41
DCP IV	Acid fine silts	D	33,45
DCP V	Markedly acid fine silts	D	21,31,35,39

SUBSOILS.

DCP VI	Alkaline clays	D	16
DCP VII	Neutral clays	D	4,12,14,18,20,44
DCP VIII	Acid clays	D	8,26,28,30
DCP IX	Markedly acid clays	D	2,10,42
DCP X	Acid heavy silts	D	22
DCP XI	Neutral fine silts	D	34,36,46
DCP XII	Acid fine silts	D	32
DCP XIII	Markedly acid fine silts	D	40

TABLE IV.

COMPOSITE SAMPLES.

Sample	M.P.S	% Sand	I.T.	Reaction pH	Reaction Kcl pH	Lime Reqt. Tns/Acre	%Organic Matter	Soluble in 1% citric acid Solution K_2O	Soluble in 1% citric acid Solution P_2O_5
TOP SOILS.									
D.C.P. I.	49.0	10.1	47	5.32	4.23	6.4	1.46	0.0143	0.0044
II.	47.3	20.8	43	5.57	4.58	4.2	1.31	0.0103	0.0003
III.	45.3	7.0	44	5.22	4.13	6.1	1.62	0.0090	0.0015
IV.	37.2	30.8	31	5.58	4.50	3.9	1.08	0.0083	0.0006
V.	39.5	25.2	33	5.27	4.17	4.8	1.24	0.0097	0.0010
SUB SOILS.									
D.C.P. VI	46.6	4.4	46	7.75	6.60	1.1	...	...	...
VI	51.9	10.5	50	6.93	5.75	2.2	0.58	0.0058	0.0017
VI	49.0	5.7	48	6.05	4.95	3.5	0.60	0.0060	0.0005
IX	46.1	6.7	45	5.03	4.28	4.3	0.79	0.0077	0.0003
X.	45.8	8.0	44	5.75	5.40	...	...	...	...
XI	39.9	33.2	33	6.88	5.78	1.5	0.48	0.0053	0.0003
XI	41.4	26.2	36	6.25	5.70	2.4	...	...	...
XI	42.3	21.0	38	5.05	4.45	5.2	...	...	...

TABLE V.

MEAN REACTIONS OF SAMPLES FROM CLOSED DRAIN AND OPEN DRAIN AREAS.

	Topsoils		*Subsoils*	
	Normal Reaction (pH)	Exchange Reaction (Kcl pH)	Normal Reaction (pH)	Exchange Reaction (Kcl pH)
Closed-drain area	5.52	4.25	6.47	5.18
Open-drain area	5.36	4.18	6.45	5.24

NOTES ON FIELD EXPERIMENTAL METHODS

BY

F. BURNETT, M.C., M.A., (OXON.)

AND

R. R. FOLLETT-SMITH, B.Sc., A.R.C.S.

In recent years much attention has been paid to the design of methods of laying down field trials and to the statistical examination of the results obtained.

It is apparent that the fertility of an experimental area may vary from point to point. The effect of any particular treatment may thus be masked or may be markedly enhanced. The aim of modern field experiments is to assess and eliminate the differences due to variation in soil fertility so that a more accurate determination of the effects of treatment may be obtained.

In order that the statistical treatment of the results of the various agricultural experiments now being conducted by the Department may be understood by the agriculturists of British Guiana and with the view of assisting those that are desirous of conducting their own experiments on any particular crop, two examples of the latest types of field experiments, kindly furnished by Mr. A. R. Clapham of Rothamsted, are here set out. Such experiments not only furnish results of greater precision, but effect considerable economy in space.

In the past it has been regarded as a fairly simple process to carry out an agricultural field experiment, but under the present day requirements that view must change and an Experimental Station should be regarded as a highly scientific research laboratory. In the review by Mr. F. A. Stockdale, C.B.E., Assistant Agricultural Adviser to the Secretary of State for the Colonies, on the Report of the Royal Commission on Agriculture in India, the following appears:

" The report emphasises that the basis of Agricultural progress is experiment "and that however efficient the organisation for demonstrative propaganda, it is " likely to be ineffective unless it is based upon accurate data secured by research. " It is therefore imperative that carefully planned field agricultural experiments " be continually conducted and results statistically treated according to the latest " methods, before demonstration and extension can be proceeded with."

Accordingly, future experiments will conform to one or other of the two designs described below being modified only in regard to the number of treatments and blocks.

The following are the two designs and the method employed of calculating the results shown step by step:

(I) *The randomised block pattern.* This type will be used for determining the effect of certain definite factors and of their interactions upon yield.

(II) *The latin square pattern.* It often happens, that experimental stations are concerned with a straightforward comparison of yield of a mumber of different varieties or treatments, or with the determination of the optimum dressing of any one manure. In such cases the latin square pattern will be found to be an inexpensive and simple arrangement.

The layout, treatments and yields are set out in Figures I, II and III. The arrangement consists of 9 randomised blocks of 9 plots each. The area of each plot is 0.0125 acre.

All plots received superphosphate at the rate of 4 cwts. per acre. Sulphate of Ammonia and Sulphate of Potash at the rates of 0 cwts., 2 cwts. and 4 cwts. per acre were applied in all combinations, giving nine treatments in all:—

TREATMENT KEY.

	A	B	C	D	E	F	G	H	J
Sulphate of Ammonia cwts.	0	0	0	2	2		4	4	4
Sulphate of Potash cwts.	0	2	4	0	2	4	0	2	4

Layout. FIG. I.

	I			II			III			
	G 273	D 329	F 263	D 250	H 286	A 230	D 295	C 209	E 289	
	C 258	E 261	H 309	J 238	G 323	F 374	F 180	J 265	A 201	
	J 268	A 157	B 215	B 219	E 301	C 267	G 222	H 244	B 233	
	E 257	B 184	G 271	E 281	H 327	G 311	J 248	E 269	B 254	
IV.	H 299	F 259	C 192	F 312	D 271	B 209	C 217	D 379	F 240	VI.
	J 289	D 270	A 246	J 314	A 226	C 197	A 203	G 172	H 297	
	A 286	B 217	G 300	D 276	F 240	J 283	C 180	F 204	H 260	
	C 187	D 254	E 232	H 286	B 162	G 313	A 201	B 192	G 276	
	J 258	H 308	F 239	E 228	A 181	C 288	E 230	D 254	J 306	
	VII			VIII			IX			

The letters denote the treatments, while the figures give the yield in lbs.

Treatment Yields. FIG. II.

SULPHATE OF AMMONIA.

	Treatment	0 cwts.	2 cwts.	4 cwts.	Total	Mean
Sulphate of Potash	0 cwts.	1931 214.6	2578 286.4	2461 273.4	6970	258.148
	2 cwts.	1885 209.4	2348 260.9	2616 290.7	6849	253.667
	4 cwts.	1995 221.7	2311 256.8	2469 274.3	6775	250.926
	Total Mean	5811 215.200	7237 268.037	7546 279.481	20594	254.247

The upper figure is the total while the lower figure is the mean.

Block Totals. FIG. III.

I	II	III	IV	V	VI	VII	VIII	IX	TOTAL	MEAN
2333	2488	2138	2267	2448	2279	2281	2257	2103	20594	254.247

It is seen that there are nine treatments (A—J) and that each one occurs randomly in each block only once. The blocks and plots need not be squared. The blocks may be separated slightly to avoid unequal patches of land or drains, and need not be placed contiguously as shown in the figure. The statistical examination of the results will now be followed step by step :—

STEP 1.

The treatment yields are set out as in figure II. The yields from all plots receiving treatment A are added together and the total (1931) and the mean (214.5) are placed in their appropriate square. The total (1885) and mean (209.4) yields of all plots receiving treatment B are similarly treated.

The totals in each column and each row are added together to give column and row totals and means.

The grand total (20594) and the grand mean (254.247) should be identical whether they be obtained by adding the row totals or the column totals.

The block totals are found by adding together the yield from each of the nine plots in the particular block.

STEP 2.

Analysis of Variance. The variance is split up into a part due to treatment, a part due to soil variation between blocks and a residual variance which forms the basis of the test of significance of the results obtained. Draw up a diagram as below :—

FIG. IV.

VARIANCE DUE TO :—	DEGREES OF FREEDOM	SUM OF SQUARES	VARIANCE
Treatment ...	8	70,467.73	8,808.47
Blocks	8	13,986.84	1,748.36
Residual	64	91,960.49	1,436.88
TOTAL	80	176,415.06	2,205.19

The figures in the diagram were arrived at in the following manner.

Degrees of Freedom.

There are nine different treatments and therefore (9—1)=8 degrees of freedom corresponding to treatment.

There are nine blocks and therefore (9—1)=8 degrees of freedom corresponding to blocks.

There are 81 plots and therefore (81—1)=80 degrees of freedom corresponding to the total variance.

The residual degrees of freedom are 80—(8+8)=64.

Sum of Squares.

Total. Add together the squares of all plot yields ($273^2+329^2+263^2+250^2+ \text{---} + \text{---}$). Subtract from this the square of the total yield over the whole area divided by the number of plots ($20591^2 \div 81$). The figure obtained is called the total sum of squares, (176,415.06).

Treatment. Add together the squares of each treatment yield ($1931^2+2578^2+2461^2+ \text{---} + \text{---}$). Divide by nine for each figure is the total of nine plots. Subtract the same correction as before ($20594^2 \div 81$). This gives the sum of squares due to treatment (70,467.73).

Blocks. Add together the squares of each block yield ($2333^2+2488^2+2138^2+ \text{---} + \text{---}$). Divide by nine for each figure is the total of nine plots. Subtract the same correction as before ($20594^2 \div 81$). This gives the sum of squares due to blocks, in this case 13,986·84.

Residual. This sum of squares is most easily obtained by subtracting the sum of squares due to treatment *plus* that due to blocks from the total sum of squares. The figure obtained is 91,960.49.

Variance. The variance is obtained by dividing the sum of squares by their appropriate degrees of freedom.

Step 3.

The variance due to treatment (8,808.47) is split up into portions due to nitrogen alone, potash alone and a remainder giving a measure of the interaction of the nitrogen and potash.

Thus:—

FIG. V.

VARIANCE DUE TO :—	DEGREES OF FREEDOM.	SUM OF SQUARES.	VARIANCE.
Treatment ...	8	70,467.73	8,808.47
Nitrogen	2	63,446.68	31,723.34
Potash	2	717.80	358.90
Interaction ...	4	6,303.25	1,575.81

The figures in the diagram were arrived at in the following manner.

Degrees of freedom.

There are three different nitrogen treatments and therefore $(3-1)=2$ degrees of freedom.

There are three different potash treatments and therefore $(3-1)=2$ degrees of freedom.

The interaction degrees of freedom are therefore $8-(2+2)=4$.

Sum of Squares.

Nitrogen. Add together the squares of the separate totals of each nitrogen treatment $(5811^2+7237^2+7546^2)$, divide by 27 because these are totals of 27 plots, and subtract the same correction as before, $(20594^2 \div 81)$. The figure obtained is 63,446.68.

Potash. Add together the squares of the separate totals of each potash treatment $(6970^2 + 6849^2 + 6775^2)$, divide, as before, by 27, and subtract $(20594^2 \div 81)$. The figure obtained is 717.80.

Interaction. The sum of squares is obtained by difference of the above two amounts from the total 70,467.73. The figure obtained is 6,303.25.

Variance. The variance is obtained by dividing the sum of squares by the appropriate degrees of freedom.

STEP 4.

A full analysis of the variance, combining the two previous tables is set out.

FIG. VI.

VARIANCE DUE TO	DEGREES OF FREEDOM	SUM OF SQUARES	VARIANCE	½ $\log_e$ VARIANCE
Nitrogen ...	2	63,446.68	31,723.32	5.1824
Potash ...	2	717.80	358.90	2.9415
Interaction ...	4	6,303.25	1,575.81	3.6813
Blocks ...	8	13,986.84	1,748.36	
Residual ...	64	91,960.49	1,436.88	3.6351
TOTAL ...	80	176,415.06	2,205.19	

STEP 5.

The standard error of a single plot in the experiment is calculated. It is the square root of the residual variance.

That is :—$\sqrt{1,436.88} = 37.92$.

For the comparison of the means of x plots this must be divided by the square root of x. Thus in order to compare the differences between the mean yields of the nine different treatments, the standard error is $\frac{37.92}{\sqrt{9}} = 12.64$. (There are nine plots to each treatment).

If the difference between any two treatment means (e.g. 286.4−214.5=71.9) is greater than three times the standard error (i.e. 12.64 × 3 =37.92) then it is held that the difference is real and not due to chance.

Inspection of treatment yields, Fig II, indicates that, at all potash levels, the dressing of 2 cwts. of sulphate of ammonia gives a definite increase in yield, but that a double dressing (4 cwts.) produces little, if any, further effect. Potash, in this experiment, appears to have had no effect at all.

The table of analysis of variance (Fig. VI) shows that the major effect is due to nitrogen while the variance due to potash treatment is very small. The interaction variance is only of the same order as the residual variance due to the fact that the potash produced hardly any effect.

STEP 6

The significance of the different treatments involved may be obtained by stating the variances as one half of their natural logarithm (common logarithm $\times$ 1.151292). The difference between any two of these is the "z" with which Fisher's table ("Statistical methods for research workers"—Fisher) is entered, with n_1 equal to the number of degrees of freedom corresponding to the larger variance and $n_2=64$.

Thus :—5.1824 − 3.6351 = 1.5473 = Z
n_1 = 2
n_2 = 64

For the 1 per cent. point we find from the table a value slightly smaller than 8025. Since the difference obtained (1.5473) is much greater than this, it follows that not once in one hundred times would such a difference occur by chance and that the effect of nitrogen is significant.

The effect of interaction of potash and nitrogen is not significant, for
3.6813 − 3.6351 = 0.0462.
The value in the table for the 1% point is 0.6472.
The value in the table for the 5% point is 0.4632.
The effect of interaction is therefore not significant.

STEP 7.

The three mean yields for the different nitrogen grades only are tabulated, since the potash gave no significant increases. These three mean yields are arrived at from the sum of 27 plots. For comparison of these means, therefore, the standard error is 37.92 ÷ √27 = 7.30.

The yields are finally stated as tons per acre and also as percentages of the general means (254.217).

FIG. VII.

	NO. NITROGEN	2 CWTS. S. OF AMM.	4 CWTS. S. OF AMM.	MEAN	STANDARD ERROR
Tons per acre	7.7	9.6	10.0	9.1	0.26
Per cent ...	84.7	105.4	109.9	100.0	2.87

STEP 8.

The experiment is summarised thus :—

Potash produces no effect, while there was significant response only to the single dressing of nitrogen.

II.

An example of the latin square type of experiment will be considered. The general conditions of arrangement are :—

(1) That the number of plots available shall be the square of the number of treatments or varieties tested.

(2) That the treatments be randomly arranged within the square, with the following restriction :—

Each treatment occurs once in each column and once in each row.

Arrangement.

a 5 x 5 Latin Square.

Treatments.

C Control no application of phosphate.

S Super at the rate of 100 lbs. P_2O_5 per acre.

L Low soluble slag (37.3%) }
M Medium soluble slag (60.9%) } equivalent to superphosphate.
H High soluble slag (86.8%) }

STEP 1.

The arrangement of treatments, row totals and means, plot yields, column totals and means and treatment totals and means together with the grand total and general mean are set out as in Figs. I and II.

FIG. I.

						Total	Mean
	C 724	S 1132	H 1067	M 1031	L 923	4877	975.4
	L 915	C 824	S 1123	H 1053	M 1037	4952	990.4
	S 1024	H 886	M 977	L 881	C 745	4513	902.6
	M 879	L 722	C 683	S 1025	H 947	4256	851.2
	H 1035	M 904	L 877	C 757	S 929	4502	900.4
Total	4577	4468	4727	4747	4581	23100	4620.0
Mean	915.4	893.6	945.4	949.4	916.2	4620.0	924.0

Treatment Yields. FIG. II.

	C	L	M	H	S
Total	3,733	4,318	4,828	4,988	5,233
Mean	746.6	863.6	965.6	997.6	1046.6

STEP 2.

The following table, Fig. III., of analysis of variance is then set out:

FIG. III.

Variance due to:—	Degrees of freedom	Sum of Squares	Variance	$\frac{1}{2}\log_E$ Variance
Rows	4	66,828.4	16,707.1	
Columns	4	10,810.4	2,702.6	
Treatments	4	286,486.0	71,621.5	5.5896
Residual	12	32,757.2	2,729.8	3.9560
Total ...	24	396,882.0	16,536.8	

The figures in the diagram were arrived at in the following way.

Degrees of freedom.

There are 5 rows and therefore (5—1)=4 degrees of freedom corresponding to rows.

There are 5 columns, therefore (5—1)=4 degrees of freedom corresponding to columns.

There are 5 treatments and therefore (5—1) = 4 degrees of freedom corresponding to treatments.

There are 25 plots and therefore (25—1) — 24 degrees of freedom in total.

The residual degrees of freedom are 24 $-(4+4+4)$ 12.

Sum of Squares.

(a) *Total.* As in the last example this is found by adding together the squares of all the plot yields ($724^2 + 1132^2 + 1067^2 + \cdots + \cdots$) and subtracting the square of the grand total divided by the total number of plots ($23100^2 \div 25$). The figure obtained is 396,882.0.

(b) *Rows.* Add together the squares of the row yields ($4877^2 + 4952^2 + 4513^2 + \cdot + \cdot$) and subtract the same correction ($23100^2 \div 25$). The figure obtained is 66,828. 4.

(c) *Treatments.* Add together the squares of the treatment yields ($3733^2 + 4318^2 + 4828^2 + \cdots + \cdots$) and subtract ($23100^2 \div 25$). The figure obtained is 286,486.0

(d) *Columns.* Add together the squares of the column yields ($4577^2 + 4468^2 + 4727^2 + \cdots + \cdots$) and subtract the same correction ($23100^2 \div 25$). The figure obtained is 10,810.4.

(e) *Residual.* This sum of square is obtained by subtracting the sum of squares due to treatment, rows and columns from the total sum of squares. The figure obtained is 32,757.2

STEP 3.

The variance is calculated by dividing each sum of squares by its corresponding degrees of freedom.

STEP 4.

The column $\frac{1}{2} \log_E$ variance is obtained as explained in connection with the last example.

$$5.5896 - 3.9560 = 1.6336 = z$$

n_1 = 4 (degrees of freedom associated with treatment).

n_2 = 12 (" " " " " residual)

Fisher's table of z indicates that a difference of 0.8443 would occur only once in one hundred times, the treatment therefore undoubtedly had a significant effect.

STEP 5.

The standard error of one plot is $\sqrt{2,729.8} = 52.24$. (The square root of the residual variance). In comparing the treatment averages which are the means of 5 plots we divide this value (52.24) by the square root of 5.

$$\frac{52.24}{\sqrt{5}} = \frac{52.24}{2.2361} = 23.4$$

The five treatment means are compared with each other in the light of a standard error of 23.4 in the following table (Fig. IV).

FIG. IV.

Treatment	Control	Low sol.	Med. sol.	High sol.	Super	Mean	Standard Error
Yield in lbs.	746.6	863.6	965.6	997.6	1046.6	924	23.4

All treatments have produced a significant increase over the control plot, the superphosphate doing best of all. Of the intermediate values (taking three times the standard error as significant) we see that medium, high and super are significantly better than low, while super is significantly better than medium.

STEP 6.

The final results of the experiment are set out as in Fig. V.

FIG. V.

Average Yield	Control	Low sol.	Med. sol.	High sol.	Super	Mean	Standard Error
Tons per acre	8.3	9.6	10.8	11.1	11.7	10.3	0.26
Per cent.	80.3	93.5	104.5	108.0	113.3	100.0	2.53

General Remarks.

Although the plots are shown in the two examples as lying contiguously, yet in actual field work the blocks in the randomised block pattern may be separated to avoid drains or obviously infertile patches. If the number of treatments in one block is large (*e.g.* 32 in the cane experiment at Sophia,) the number of blocks laid out must be, for reasons of economy in space and manures, small. In such a case the blocks are split up into comparable half blocks for the better control and estimation of soil variation.

The rows in a latin square arrangement need not be placed in the field in the form of a square, but may, if necessary, be placed end to end in one continuous strip.

THE ERADICATION OF THE WEED ANTIDESMA GHESAEMBILLA.

BY

E. B. MARTYN, B.A.,

Botanist and Mycologist.

Antidesma Ghesaembilla Gaertn., known locally as 'Antidesma,' 'Wild Jamoon,' 'Congo Bush,' 'Baby Apple' or 'Souri' was apparently introduced into the Botanic Gardens from the Eastern Tropics some fifty years ago. Since its original introduction it has become a troublesome weed in the Gardens, and has spread over most of the waste land in their neighbourhood, in some cases forming extensive stands of the nature of 'young coppice.' If left to grow unhindered, the plant develops into a bush or small tree. If cut back, however, a number of suckers arise from the stump and others from the adjacent roots. The more often the plant is cut back, the more extensively it suckers, usually developing into a large stump from which a number of branches arise, surrounded by a series of smaller clumps from root suckers. Such treatment also causes the plant to flower more readily, the seed so produced furthering its dissemination.

The roots penetrate the soil for considerable distances, in one instance a length of 40 feet having been recorded, and for this reason attempts at eradication by removal of stumps and forking out are never completely successful, since isolated fragments are invariably left in the soil, which are sufficient to re-establish the plant.

Various methods of eradication have been attempted in the Gardens from time to time, but without success. They included the application of salt to the base of the plants, and also cropping at regular intervals. In the case of this latter treatment, on plots cut back once a week, the plant showed no signs of exhaustion after the treatment had been repeated over twenty times.

Other methods having failed, the possibilities of killing the plant with inorganic poisons were investigated. Both Copper Sulphate and Sodium Arsenite were tried, of which the latter proved the most effective. (1) The application has followed two lines, spraying clumps of the plant and poisoning individual trees.

SPRAYING.

A selected area is cleared of grass, etc., and the Antidesma cut back to ground level. Stumps should be treated separately, as described below. As new suckers arising attain a height of some six inches, they are sprayed with a 1% solution of Sodium Arsenite, which kills them. After a short period another crop of suckers arises, (somewhat more numerous than the first) and is similarly treated. Subsequently three or four more 'springs' of suckers arise, each now

less plentiful than the one before, and are killed in turn. At the final spraying only a shoot here and there remains to be poisoned. About six months are usually required before eradication is complete, the time depending, however, upon the rate at which the successive 'springs' develop.

Throughout, the ground under treatment must be kept cleared, in order that no suckers may be overlooked when spraying. To ensure this in the earlier stages, it is often advisable for the men carrying out the operation to move between lines pegged down on the ground, each man being responsible for the Antidesma shoots between two lines, and the whole area thus being covered methodically. Careful supervision of the labour is necessary. Spraying must of course be carried out during dry weather.

Costs of Spraying.

The costs of eradication vary considerably in accordance with the density of the Antidesma. The initial cutting and clearing is the most expensive operation, especially in heavily infested land, and it is important that the area cleared at any one time be not larger than can be sprayed with the facilities available, and under the probable weather conditions, otherwise the land will have to be cleared again, entailing further unnecessary expenditure.

The first area to be cleared in the Gardens was one in which there was practically a pure stand of the plant, that had covered the ground for many years, forming a thicket of tall bushes arising from large stumps, the roots of which permeated the soil in all directions. On cutting back, the resulting suckers were very numerous and persistent.

The original cutting and clearing of this area cost $33.00 per acre. It was sprayed seven times, the maximum application (at the second spraying) being 625 gallons per acre, whilst the final application only required 23 gallons per acre. The total amount of poison applied was approximately 2,000 gallons per acre. The Sodium Arsenite costing 5.4 cents per lb. (exclusive of duty and freight), this brings the cost of the 1% solution of weedicide to $10.80 per acre. The cost of labour for spraying was $40.00 per acre giving a total cost of approximately $84.00 per acre.

Another area has, however, been treated subsequently, where the Antidesma though plentiful, was not so long established, and occurred rather as scattered clumps. Cutting and clearing in this case cost $22.50 per acre. The total amount of poison applied was approximately 600 gallons per acre, including a maximum application of some 200 gallons per acre and a final application of 10 gallons. This brings the cost of the poison to $3.24 per acre. Labour for spraying cost $15.00 per acre, giving a total cost of approximately $41.00 per acre. To these figures must be added the cost of supervision, and that of the machines used, which were in this case, Four Oaks Knapsack Sprayers.

Poisoning of Stumps.

This has been carried out effectively on a number of Antidesma trees growing in the wind belt on the north side of the Gardens. The trees were cut down with a saw, leaving stumps some 6—8 inches high, with a clean surface. Holes were bored in these with a one inch or half inch auger, filled with a 10 per cent. solution of Sodium Arsenite, and plugged. It is essential that a stump large enough to take the auger holes be left when cutting down the trees, and that where stumps have branched near the ground (owing to previous cutting back) each branch or section of the stump be bored separately. The holes need refilling after an interval of about a fortnight, and this second filling may suffice to kill the stump, or a third may be necessary. Spraying is of course carried out in conjunction with this operation, to kill any suckers which have arisen from the roots in the neighbourhood of the parent stump, and plants which are too small to be bored.

Cost of Poisoning the Stumps.

In all, 290 trees were cut and bored, and it required 54 gallons of solution to fill the holes. All had to be re-filled a second time, requiring another 54 gallons. 61 of these stumps were treated for a third time, using 10½ gallons. This amounts approximately to 41 gallons of 10% Sodium Arsenite per 100 trees, costing $2.21. The cost of labour was $9.58 per 100 trees, giving a total cost of $11.94, say $12.00 per 100 trees.

More recent experimental work has, however, indicated that a 5% solution of the weedicide is sufficient to kill the stumps.

Necessary Precautions.

In the eradication of Antidesma with Sodium Arsenite, certain precautions are necessary (a) to ensure the success of the operations and (b) as safeguards when using a substance which is a very dangerous poison. In the first place, any area to be treated must be carefully examined, and a note made of the whereabouts of all the Antidesma, in order that isolated plants are not overlooked. The area must then be worked over methodically, avoiding the clearance of too much at a time. Finally, after the weed has been eradicated on any piece of ground, if there is more Antidesma in the near neighbourhood, this should not if possible be allowed to flower, and an occasional examination of the treated area should be made, to discover any seedlings which may have been introduced by birds. If found in time, however, these can easily be uprooted.

As in any operation of this nature, labourers who have had some experience of the work are able to give the best results, becoming more adept in handling the machines and the weedicide, and more readily able to see the Antidesma shoots.

As a safeguard, labourers should wear some covering to their feet, and carry a piece of sacking over their shoulders in case of any leakage from the machines.

Care must also be taken to keep cattle, etc., away from areas where spraying is in process, and to avoid the pollution of water. The Sodium Arsenite is extremely corrosive, and the spraying machines, etc., must be washed out daily after use.

OTHER METHODS OF CONTROL.

Treatment with weedicide is apparently the only means by which complete eradication of the Antidesma can be effected, and this is seen to be an expensive operation. The plant is not usually found in cultivated land, but sometimes proves troublesome when occurring on waste land which is to be taken into cultivation again. When such land is to be put under cane, if the Antidesma be dug out as far as possible in the first instance, a heavy crop of cane would probably smother it to some extent, though it would never be eradicated. In this connection, the possible effect of prolonged flooding should also be considered. A small patch of Antidesma in the Gardens was kept continuously submerged for 4 months. About a month after the water was let off, the plant began to grow again, though very weakly at first. It is possible, however, that if infested land could be kept submerged for a year or more, the Antidesma would be killed, or at any rate so weakened as greatly to facilitate eradication by other means, such as poisoning.

In conclusion it may be stated that the Sodium Arsenite, when sprayed on the plants, does not appear to have any permanently harmful effect on the soil, which though bare for a few weeks, is soon covered with grasses and other weeds.

(1.) Report of Dept. of Sci. & Agri., for 1926. Appendix III.
Report of the Assistant Botanist & Mycologist.

CROP TABLE

BY

H. D. HUGGINS, D.I.C.T.A.,

Asst. Agricultural Superintendent, Demerara.

The Crop Table is intended for reference purposes only and the data given have been collected, whenever possible, with due regard to local conditions and practices.

It is possible that, with further experimentation, some of the information given will need modification ; it is also probable that under the widely differing local conditions, results, not entirely in agreement with those stated, may have been discovered, by experience, in certain instances. This may be expected. If, however. the limitations of the Table be recognised it is hoped that the facts and figures given may be of some use to agriculturists generally.

It will be observed from the table that under the heading "Nursery" the only information given for citrus crops is "Budding advised." In columns such as these it is not possible to give fuller information on the correct method and the resulting advantages of budding.

It suffices to state that the advantages which accrue from budding, such as uniformity of fruit and of yield, early maturity of trees, resistance to disease and unfavourable soil conditions, make it imperative that this operation be practised in citrus culture. As to the correct method, organisation of the work in the nurseries of this Department has been planned with a view to producing thousands of budded citrus plants with as little delay as possible. It is therefore expected that the supply will be able to meet the demand in this connexion and, further, any agriculturist so desiring, is given every facility for obtaining training and practice in budding.

As regards the distance apart of planting certain crops *(e.g.* Cassava) there may be more than one spacing distance practised locally ; the figures given in the table, in such cases, are those adopted when no intercropping occurs.

In the case of Bananas, Plantains and Pineapples, the figures given for the "average yield per acre" can only be reconciled with the figures given for the number of plants per acre if it be remembered that, with the systems of "ratooning" practised, more than one bunch of bananas and plantains and more than one pineapple is reaped per year, after the first crop, from each "clump."

CROP TABLE.

Crop	Optimum Environmental Conditions	Nursery		Planting Material Necessary for 1 Acre	Spacing in Field	Period between Planting in Field and Reaping	Average Yield per Acre
		Period in	Spacing in				
Liberian Coffee	Below 1,500 ft. well-drained loamy soil, 55°-80°F. Moderately heavy rainfall	8-10 months	8″-12″ apart *	302 selected seedlings	12′ x 12′	3-5 years	400-1,000 lbs. clean coffee with av. of 500 lbs.
Coconut	Within 20° of equator 70-80 inches of well distributed rainfall. Sandy loam	8-12 months	Continuous	48 selected seedlings	30′ x 30′	6-10 years	2,000-3,000 nuts
Cacao	Warm, moist climate with little exposure, deep, well-drained, rich soil shade	4-6 months	4″ x 9″ *	193-302 selected seedlings	12′-15′ apart	5-7 years	250-600 lbs. dry cacao
Orange	Tolerant but prefers rich, deep, well-drained loams in warm moist localities	Budding	advised	70-108 selected plants	20′-25′ apart	3-5 years	60,000 oranges
Lime	Tolerant but prefers rich, deep well-drained loams: hot, moist localities	Budding	advised	109-302 selected plants	12′-20′ apart	3-5 years	80-160 barrels †
Grapefruit	Deep, medium-textured, fertile, well-drained loams with average annual rainfall of about 75 ins.	Budding	advised	48 selected plants	30′ x 30′	3-5 years	150-300 boxes

*Use of baskets or bamboo pots recommended.
†1 barrel contains approx. 160 lbs. of limes

CROP TABLE.

Crop	Optimum Environmental Conditions	Nursery		Planting Material Necessary for 1 Acre	Spacing in Field	Period between Planting in Field and Reaping	Average Yield per Acre
		Period in	Spacing in				
Para Rubber	Moist climate within 10° of Equator below 2,500 ft. Rich alluvial soil	6-8 months	6″ x 6″ *	108-150 selected seedlings	17′-20′ apart	5 years	80-400 lbs. latex
Nutmeg	Alluvium formed of deep, well-drained loam in hot moist climate at elevation less than 1,500 ft.	1 year. Until seedlings 2′-3′ high	8″-12″ apart *	48-69 selected seedlings	25′-30′ apart	7-15 years	1,100 lbs. nutmegs 275 lbs. mace
Sugar-Cane	Minimum annual rainfall of 60 ins. well-drained and neutral soil	Nurseries used only for "raising seedlings"		7,000-9,000 cuttings	In rows 5′-6′ apart and continuous in row	12-16 mon's	25-50 tons of cane
Banana (Gros Michel)	Rich sandy loams, moist tropical conditions, good drainage	..	...	193 "suckers"	15′ x 15′	12 months	150-300 bunches
Plantain	More hardy than, but requirements similar to, banana	..		302 "suckers"	12′ x 12′	10-14 mon's	280-450 bunches
Yam	Rich, light soils ; good drainage	..	...	4,840 "cuttings"	3′ x 3′	9-11 months	4-5 tons
Tannia	Sandy loam, rich in humus, warm climate, tolerant to varying moisture conditions	.		3,630 "cuttings"	3′ x 4′	9-12 months	4 tons

*Use of baskets or bamboo pots recommended.

CROP TABLE.

Crop	Optimum Environmental Conditions	Nursery: Period in	Nursery: Spacing in	Planting Material Necessary for 1 Acre	Spacing in Field	Period between Planting in Field and Reaping	Average Yield per Acre
Maize	Sandy loam ; moist conditions in growing season with dry ripening period, varied climatic conditions	.	.	18-20 lbs. of seed	3' x 3'	2½-4 months	800-15.00 lbs. per crop
Pineapple	Sandy well-drained loams	..	.	8,300 plants	18" x 42"	20 months	5,000-12,000 pines
Ginger	Rich, vegetable, well-drained loam with moderately heavy rainfall, tropical	...	...	18,700 "cuttings"	24" x 14	9-10 months	1,000-2,500 lbs. dried ginger
Tobacco	Varying soil & climatic conditions have marked effect on quality and type of Tobacco produced	5-8 weeks	Broadcast 1 teaspoonful over 90 sq. ft.	½ Teaspoonful of seed	3' x 2½' or 3' x 3'	2½-4 months	500-2,400 lbs. cured leaf
Rice (Lowland)	Flat Clay loam with underlying clay, good irrigation and drainage systems	4-6 weeks	25-30 lbs. of padi broadcast in 6 sq. rods	25-30 lbs. of padi	1' x 1'	4-4½ months	15-35 bags paddy
Cassava	Rich sandy well-drained loam, hot and moderately dry climate	...	.	6,970 cuttings	2½' x 2½'	7-12 months	5 tons
Sweet Potato	Light friable well-drained soil (with little clay) warm climate	.	...	21,780 cuttings	2' x 1'	3-7 months	4-5 tons
Soya Bean	Adapted to wide range of conditions. Locally appears to do best on light soils Requirements rather similar to those of Maize	...		30-50 lbs of seed	18" x 3" or 24" x 3"	4-5 months	1,500 lbs. of beans

CROP TABLE.

Crop	Optimum Environmental Conditions	Nursery: Period in	Nursery: Spacing in	Planting Material Necessary for 1 Acre	Spacing in Field	Period between Planting in Field and Reaping	Average Yield per Acre
Ground-Nut	Light, well-drained calcareous soil, moist conditions in early stages	.	...	40-50 lbs. of shelled seed	1′ x 1′	4-5 months	800-1,200 lbs. of unshelled nuts
Onion	Moderately rich, friable soil with showery vegetative period and dry ripening period	4 weeks	Continuously in rows 6″ apart	15 lbs. of seed	6″ x 6″	3 months	2-10 tons
Beet	Tolerant, prefers moderately rich loam and moderate rainfall	3 weeks	3″ x 1″	6-15 lbs. of seed	4″ x 12″	2½ months	8-10 tons
Castor Seed	Hardy and withstands wide ranges of climate; prefers rich loams	...	...	10-20 lbs	6′ x 6′ apart	7-9 months	500-900lbs. seed
Broom Corn	Moist vegetative season and dry ripening season; well-drained sandy loam	...	.	17 lbs	18″ x 12″	3 months	400 lbs. of clean straw
Black Eye Pea	Loamy soil; very moderately moist conditions; good drainage	...	...	4-5 gallons	Broadcast	3 months	700-1,000 lbs.
Pigeon Pea	Deep well-drained calcareous soil, tropical	...	...	4-6 lbs.	5′ x 5′ to 10′ x 10′	8 months	300-1,000 lbs.

REPORTS.

TRADE MISSION TO CANADA BY THE DIRECTOR OF AGRICULTURE.

(JULY 15—NOVEMBER 1, 1929.)

Reference to the Trade Mission to Canada, undertaken by the Director of Agriculture during the summer of last year, has been made in previous numbers of this Journal. It will be remembered that this mission was undertaken at the request of the Chamber of Commerce and arose out of consideration of the Colony's participating in the Canadian Exhibitions held in Toronto and St. John in 1929. Finally, the recommendation was put forward that Professor Dash should first visit the Dominion with a view to obtaining first-hand information of the trade and commerce in such products as the Colony was capable of producing. Those of special importance being: Sugar, Rice, Coffee, Coconuts, Copra and Timber. Government acquiesced to the request of the Chamber and eventually the mandate included instructions to stimulate, as much as possible, Canadian Trade with British Guiana.

The findings have been recently published in the form of a Sessional Paper, which was laid before the Legislative Council The following are the main headings of the Report: *Publicity and Trade Representation; Sugar and By-products, Rice; Coffee; Starch and Starch Products; Miscellaneous Agricultural Products; Fruit and Fruit Products; Fresh Vegetables; Forest and Mineral Products.* Readers will be impressed with the wide publicity which the Colony obtained through the columns of the more important Canadian newspapers, while the various headings as outlined above have received comprehensive treatment in the 25 pages of the document.

SUGAR AND BY-PRODUCTS.

The investigations relating to Sugar and its by-products centred largely on tariff questions. Under the existing tariff there were certain loop-holes which permitted Canadian wine manufacturers to enjoy full drawbacks on foreign refined sugar; there seemed to be a further loss in trade to the Caribbean Colonies through the increasing importation, by the canning and preserving trades, of suchar and other refinery syrups from the United States at a low rate of duty. To meet these difficulties, there were put forward suggestions which would give to British Guiana and West Indian producers the full benefit of the Trade Agreement.

RICE.

As the investigations on the rice trade with the Dominion may be considered the *magnum opus* of this mission, a full presentation of the economic factors

bearing on the rice situation is made and covers 8 pages of the report.

Rice, from an industrial standpoint, is classified as follows :—

(1) Rough rice, commonly called paddy.

(2) Brown or Cargo rice, *i.e.*, rice from which the hulls only have been removed.

(3) Milled rice.

Demerara rice, as at present produced, is first parboiled and then milled and falls into category 3. The rice is. however, neither highly polished nor glazed and should be classified as "parboiled rice" to avoid confusion with true *brown* rice, and to distinguish it from other types of "cleaned or milled" rices.

It was seen that in Canada, as in the United States, almost the entire demand was for glazed rices, the glazed effect being produced on the rice by a glucose-talc coating after the polishing process. For the retail trade much of this rice was sold in 1 lb. fancy cartons (see Plate VII) : the standard wholesale package being the 100 lb. jute bag.

Uncleaned rice (*i.e.* paddy and "brown" rice) was imported into the Dominion free of duty, milled rice from British Guiana admitted at 37½c. per 100 lb., and cleaned rice from foreign sources admitted at 75c. per 100 lb. Organisation and co-operation appeared to be largely responsible for permitting the United States to successfully dispose of some of their cleaned rice in the Canadian market. Thus Plate VIII shows a typical bag in which this product was marketed by the Arkansas Co-operative Rice Growers' Association, this legend being printed boldly on their bags.

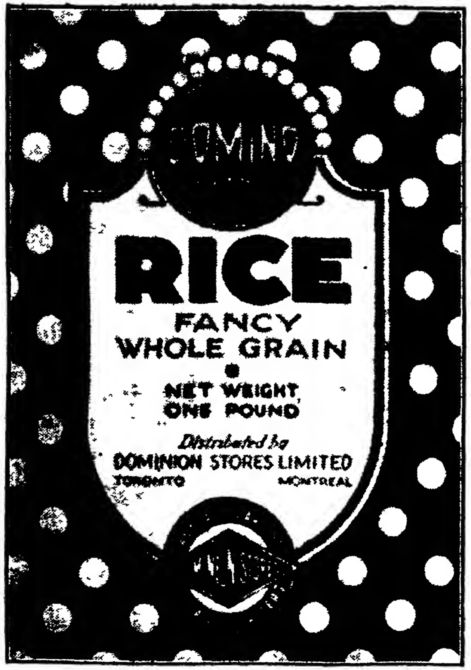
It was patent that, with the white rice trade so firmly established, much would have to be done before British Guiana could compete in this product, but there appeared to be an opportunity for the export of paddy and brown rice. In this connexion representations to the Canadian National Steamships resulted in the freight on uncleaned rice being reduced from 40 to 30 cents per 100 lbs. and on clean rice from 60 cents to 30 cents per 100 lbs.

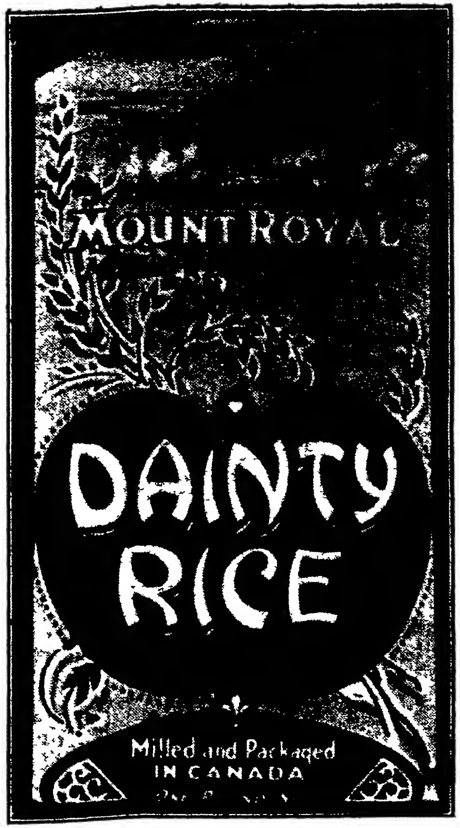
Col. Wallis, the General Manager of the Mount Royal Rice Mills, indicated the paddy types that would be suitable for the manufacture of white rice in Canada, and kindly arranged for this Department to be supplied with one ton of Blue Rose seed paddy—a variety which was being extensively cultivated in the Southern States. Col. Wallis was also induced to visit the Colony and to make such recommendations as might be helpful in building up the industry on modern lines.

There then follows, in the report, a discussion of the commercial considerations bearing on the trade in rough and milled rice together with information as to prices ruling for the different types.

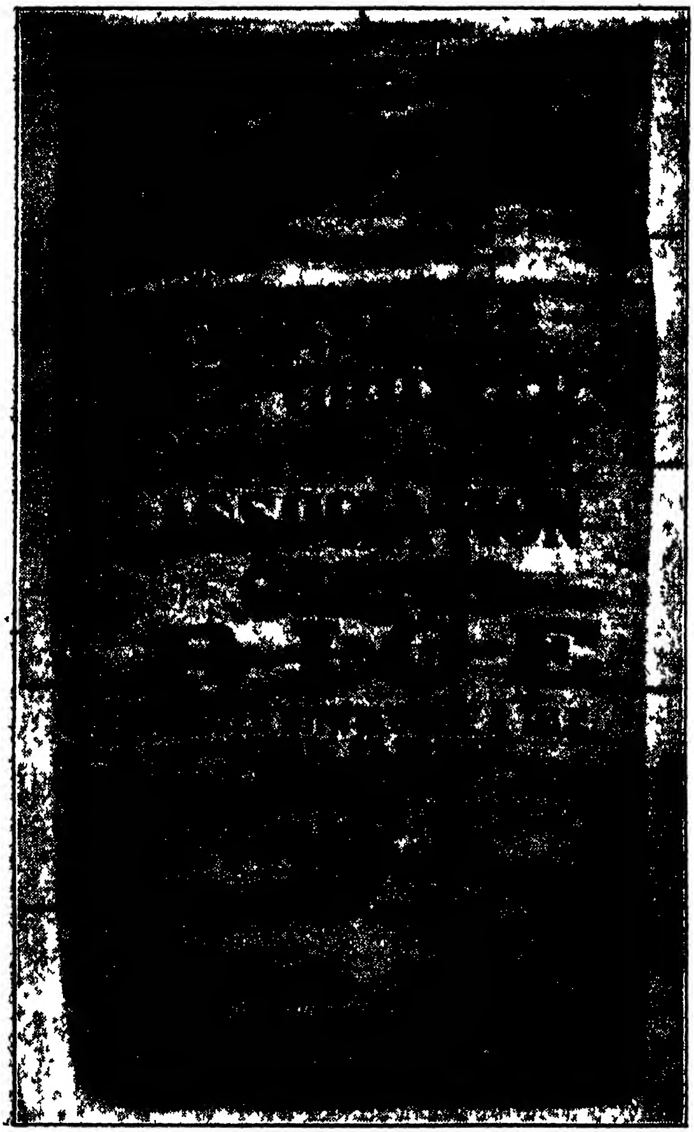
Samples of local rice straw were asked for in connexion with the manufacture of light brooms.

PLATE VII.





Fancy Cartons in which White Rice is retailed in the Dominion.



Type of bag in which Cleaned Rice is co-operatively marketed in Canada by Arkansas growers.

A study was made of the organisation of the Wheat Pool which was formed with a view to ensuring a fair price to the Canadian farmer for his wheat. The whole structure was organised, financed and managed by the Prairie Grain Farmers on purely co-operative lines. These studies were made in order to collect information on co-operative methods of handling grain.

The report summarises the information bearing on the rice situation as follows :—

"1. The present market in Canada is an exacting one, practically all rice being polished and coated.

2. The existing mills import *rough* and *brown* rice from which cleaned rice is milled. With improved methods of selecting, cleaning and grading the paddies at present grown and the extension of types specially adapted to white rice manufacture, the Colony could export *rough* or *brown* rice advantageously as is done in most rice producing countries.

3. With care and suitably introduced to the consumer by direct advertising methods, high grade Demerara parboiled rice—from the interest exhibited in it as a result of the initial propaganda undertaken on this tour—can be marketed in Canada. The extent of the trade will depend on quality (general appearance, uniformity, keeping ability, freedom from mustiness, etc.) and dependability of supplies.

4. With steady expansion of the industry, the production of white rice and its various associated by-products—which command a ready sale—should be the final goal in the building up of an extensive export trade overseas and in the Colonies of the Caribbean not at present supplied.

5. The formation of a central organisation to take care of all commercial problems relating to the industry cannot be longer delayed."

COFFEE.

Samples of locally grown Liberian coffee were shown to some of the leading coffee dealers who spoke very favourably of the quality, and expressed the opinion that, since coffee produced in the Caribbean area enjoyed a preference of 3 cents per lb. on the Canadian market, there was no reason why trade in this commodity should not increase. There should, however, be some improvement in the present methods of preparation and disposal.

COCONUTS.

Since Ceylon desiccated coconut was now entering Canada with a duty of 2 cents per lb., as compared with 5 cents per lb. previously, the outlook for increased trade in dried coconuts with Canada appeared uncertain. It was noted

that there was no demand for copra in Canada although both coconut and palm oil were imported through the United States for soap manufacture. It would appear, therefore, that a local oil plant could be of much assistance.

MISCELLANEOUS.

There was little likelihood of establishing a trade in cassava products (starch and tapioca) in the near future because of the competition in these commodities from Eastern countries where there was an ample supply of cheap labour.

The unfavourable report on brooms, grown under moist local conditions, showed that a Broom corn export trade would probably prove exacting and unprofitable, but the possibilities for ground nuts (of the confectionery type) and for peas and beans were considerable.

With reference to fruit, the failure of the Surinam banana industry under similar soil conditions, the difficulties of transport and organisation and the limiting factors discussed in a previous number of this Journal could lead to no other conclusion than that there was little promise of a banana trade being developed in the near future. The Dominion markets could absorb considerably more citrus—particularly grapefruit. In addition, there were splendid opportunities for fresh and canned pine, a limited demand for avocadoes and mangoes, while the demand for guava products, *e.g.*, guava jelly, could be very appreciably increased, if standardised methods of manufacture and packing were practised.

The demand for fresh vegetables was very great and, although it might appear that this and the West Indian Colonies could find a substantial outlet for such products during the winter months, it should be remembered that proximity to market was an important factor in an export trade of perishable produce. One great practical difficulty lay in the infrequency of the steamer calls which resulted in an unduly high proportion of wastage between boats. For any measure of success to be obtained in this direction locally, much experimental and organisation work would have to be undertaken. Enquiries were received from reliable sources for samples of Colony wood for veneer purposes and also for ski-manufacture and there were indications that it would be advantageous to stage exhibits of Colony woods at the Toronto and other Canadian Exhibitions.

Efforts to interest manufacturers in Balata were not very successful; rubber was replacing balata in beltings, being more lasting at high temperatures and vulcanisable.

Enquiries were received for "fine quality black diamond carbon."

The report contains numerous statistical tables which should be of the greatest reference value, supplying, as they do, information with especial reference to the present condition of the Canadian markets and indicating avenues along which potential development of trade in the Colony's products may be expected to proceed.

The above is a brief summary of the report (see Legislative Council No. 1/1930 and C. S. O. No. 650/30) of the Director of Agriculture's trade mission, which, as previously noted, had as its object the study of Canadian conditions and the stimulation of Canadian trade with British Guiana, which necessitated for its performance the investigations and activities mentioned, and which aspired for its conclusion that (in the closing words of the report) "the information furnished would be of some assistance to the Colony's agricultural and commercial interests." As to the far-reaching effects and ultimate advantages of such an undertaking it is not easy to speculate.

H. D. HUGGINS.

REPORT OF THE CHIEF COLONIZATION OFFICER ON COLONIZATION AND LAND SETTLEMENT FOR THE YEAR 1929.

During the year 1929, the following important schemes relating to Colonization and Land Settlement in the Colony were undertaken in accordance with Government's Colonization and Land Settlement policy for relieving the present lack of population which is considered to be one of the chief causes of the Colony's backward state :—

NORTH WEST DISTRICT— INVESTIGATION INTO SUITABILITY FOR COLONIZATION (GOVERNOR'S MEMORANDUM NO. 2).

BUSH LOT, ESSEQUEBO DISTRICT—INVESTIGATION AND PREPARATION FOR A LAND SETTLEMENT OF 100* FAMILIES OF EAST INDIAN DESCENT. (GOVERNOR'S MEMORANDUM NO. 4).

The Following is a report on these schemes with details of progress made in connection with them.

2. *Committee.*—In order to secure the co-operation of the officers chiefly concerned in the investigation and preparation of all experimental land settlements and to advise and control the schemes generally, the following Committee was appointed by His Excellency the Governor. (Governor's Memorandum No. 3) :—

PERSONNEL

The Hon. J. S. Dash, B.S.A., Director of Agriculture.	Chief Colonization Officer and Chairman of the Committee.
The Hon B. R. Wood, M.A., Conservator of Forests.	Members.
The Hon. J. Mullin, A.I.M., F.S.I., Commissioner of Lands and Mines.	Members.
Mr. H. Thompson King, Commissioner of the North West District.	Members.
Mr. H. Haydock-Wilson (Colonial Secretary's Office).	... Secretary.

The Committee's duties are set out in the above Memorandum and during the year fifteen meetings were held.

I.

NORTH WEST DISTRICT—INVESTIGATION INTO SUITABILITY FOR COLONIZATION (GOVERNOR'S MEMORANDUM NO. 2).

3. *Reconnaissance, forest valuation, soil and geological surveys.*—On February 5, 1929, an advance survey party consisting of two surveyors, of the Lands and

*Later limited to 85 families.

Mines Department, left Georgetown for the North West District for the purpose of—

(*a*.) examining the country between Barima, Aruka, Aruau and Yarikita Rivers, as to its suitability for Colonization on the principles laid down in Governor's Memorandum, No. 1;

(*b*.) selecting a definite area for the establishment of the first experimental settlement.

About a month later, this party was joined by a main survey party consisting of five Forestry Officers from the Forestry Department and a Geological Surveyor from the Lands and Mines Department together with Mr. L. S. Hohenkerk, Deputy Conservator of Forests, and Superintendent of Forest Surveys who was placed in charge of the survey.

4. *Progress Reports on Surveys.*—Both these parties started work immediately on their arrival in the District and satisfactory progress was made and maintained throughout the survey. During the survey, progress reports were drawn up and submitted to the Colonization Committee for its information. The Committee was thus kept continuously in touch with the progress of the whole survey.

5. *Cost of Surveys.*—It is noteworthy that the survey was finished ahead of programme time and at a cost considerably less than that estimated. This was due to efficient work, good organisation and favourable weather, particularly when the work was being carried out in the swamp areas of the District. The estimated cost of the survey was $12,500 and the actual cost $8,046.13.

6. *Reports on result of Surveys.*—Reports by the Officer in charge of the survey and the Government Surveyor on the Geological Survey have been submitted and were laid at the last Session of the Legislative Council along with the report of the Chemist-Ecologist who conducted an investigation into the suitability of the soils in that part of the District under survey and at the Hosororo Experiment Station. The printing of these reports, with the necessary maps accompanying them, is still under consideration.

7. *Decision of Colonization Committee on result of Surveys.*—These reports were laid at a Meeting of the Colonization Committee held on the 25th June, 1929, and the Committee, after careful consideration, decided to inform Government that the investigation showed the nature of the country, as disclosed by the survey, was unsuitable for any organised settlement scheme. Further, any scheme, as contemplated, was entirely out of the question at least for the present, and until it could be definitely ascertained with greater detail whether it was practicable from an agricultural point of view.

8. *Proposals with regard to future settlement of District.*—The Committee nevertheless thought that no objection should be offered to the settling of the District as hitherto by small farmers and others, it being understood, however, that all applications for grants and tracts of land in the District, Exclusive

Permissions, etc., would be laid before the Committee for its consideration, as decided by His Excellency the Governor. Moreover, any scheme of land settlement formulated other than on Government lines should be submitted for the views of the Committee.

At the same time, the Committee considered that there was still much to be done agriculturally along the Mabaruma range and in this connexion steps were being taken by the Agriculture Department to initiate experiments at Wauna, a station which has recently been opened through the efforts of the North West District Farmers' Association under the guidance of the Commissioner of the District and which is situated near the Wauna Creek, a tributary of the Koriabo River.

Investigations conducted by the Chemist-Ecologist showed that similar sandy soil to that of Wauna comprised a large area of the district covered by the survey. Results of these experiments at Wauna will be of interest not only to this particular locality, but in other unsettled parts of the Colony where such sandy areas exist.

II.

BUSH LOT LAND SETTLEMENT (GOVERNOR'S MEMORANDUM NO. 4).

9. *Plans and Estimates.*—In accordance with instructions outlined in Governor's Memorandum No. 4. the Committee carefully investigated the work required for the preparation of Bush Lot, Essequebo, for a land settlement of 100 families (later limited to 85 families) of East Indian descent, based on the policy and principles detailed in Governor's Memorandum No. 1. As explained in the former Memorandum, the intention is to make Bush Lot mainly a rice growing Settlement, the Essequebo District being devoted to the cultivation of that cereal. Enough land, however, would be available for growing ground provisions and vegetables by the Settlers.

Plans were accordingly drawn up and submitted by the Public Works Department setting out the main and internal drainage systems of Bush Lot and the surrounding areas, and these were carefully investigated and estimates of the cost of putting the work in order and preparing the site selected for the Bush Lot Settlement were thereafter submitted to the Committee, together with a key plan of the local main and internal drainage systems of Bush Lot.

All estimates were carefully examined and finally reduced by the elimination of certain works which were not considered essential to the scheme. After this, they were submitted to the Governor and having received his approval, instructions were issued, at the direction of His Excellency, to all officers concerned with the carrying out of the scheme that "the work should start forthwith and proceed without any delay whatever, except such as may be caused by unpreventable circumstances."

10. *Essequebo Drainage Board.*—It was considered desirable in the interests of the scheme, to notify the Drainage Board in Essequebo to instruct the various

proprietors in Essequebo to put their drainage in proper order. The Board was also acquainted with the essential items and costs, which it was proposed should be carried out as its share of the scheme. The estimated cost of putting the Bush Lot site in order for the purpose in view and the actual expenditure incurred to December, 1929, are set out in Appendix I. to this report.

11. *Preparation of Settlement.*—The work of preparing the land for settlement and placing the existing system of drainage in satisfactory order was commenced early in the year and in order to have porper supervision, Mr. L. M. Nightingale, Inspector of Districts, was appointed Settlement Officer and took up his duties on May 1, 1929.

12. *Date of Commencement of Settlement.*—At first it was proposed to arrange for the first batch of settlers to be on the settlement by the *1st January, 1930, but this did not prove practicable owing to the curtailment of activities towards the end of the year in order to allow certain particulars in connexion with the scheme to be laid before the Secretary of State for the Colonies.

13. *Houses.*—At the end of the year, 61 houses had been erected from a design recommended by the Committee and approved by His Excellency the Governor. This style of house was similar to that adopted at Pln. Blairmont for estate labourers. The estimated cost of erecting one of these houses (with latrine) was $290.

The timber for building the houses was ordered and obtained from the Pickersgill Saw Mills, Ltd., who carried out their contract in a satisfactory manner. The total quantity of material estimated to complete the Bush Lot requirements was as follows:—

Greenheart Scantlings.	*Crabwood Scantlings.*
39,720 sq. ft.	103,162 sq. ft.

In addition, a supply of 34,000 sq. ft. of Crabwood was found necessary in order to board the roofs of the houses. A model house was erected at the back of the Botanic Gardens for the purpose of demonstrating the type of house it was proposed to erect at the Bush Lot Settlement.

14. *Preparation of ground and buildings.*—Apart form the work of constructing bridges, plank weirs, erecting houses and cleaning irrigation trenches (the latter having been left by the former proprietor in a bad state of neglect), the task of converting the land into rice beds and levelling and grading house lots proved very difficult, especially the former in the area known as the "old rubber cultivation." Owing to the rapid growth of bush and grass and the expense incurred in keeping these under satisfactory control, it was finally decided not to proceed with the further levelling of the house lots until the houses were about to be occupied.

*Arrangements have since been made to effect settlement by the 1st April, 1930.

The fencing of the pasture and the surveying of lots and paaling off was also included in the programme of work, the latter being undertaken by an officer of the Lands and Mines Department. The various items of essential works carried out at Bush Lot are shown in Appendix I.

15. *Purchase of Anna Regina.*—While the Bush Lot activities were proceeding, Plns. Anna Regina and Richmond were offered by their owner for sale. The value of these two properties to the success of the Bush Lot Scheme was apparent to everyone concerned, and, on the recommendation of the Colonization Committee, Government decided to re-purchase these properties for a sum of $75,000 as charge against the Colonization Fund. The purchase included all buildings, machinery, etc., and also a Rice Mill which was an important asset to the Bush Lot Scheme. The principal points which were taken into consideration when the question of the purchase of these properties was before the Committee are given in Appendix II. to this report.

16. *Rice Mill.*—It is intended to run the rice mill on co-operative lines and to arrange for co-operative marketing if conditions and circumstances warrant it. It is fully realised by the Committee that it will take time for the settlers and others to appreciate the benefits to be derived from the adoption of co-operative methods which have been widely established in other countries. The importance of adopting co-operative methods is difficult to exaggerate.

17. *Machinery.*—Certain sugar machinery belonging to the Anna Regina factory was disposed of and a sum of $2,812.95 realised. This amount was credited to the Colonization Fund. Steps are being taken to dispose of the remainder; most of which falls into the category of "scrap."

18. *Proposed Terms and Conditions.*—The drawing up of suitable terms and conditions to apply to the Settlement received the careful attention of the Committee and certain recommendations in this connexion were made and are shown in Appendix III.

19. *Selection of Settlers.*—This important question received attention as soon as the terms and conditions referred to above had been decided upon. The following extract of a minute by His Excellency the Governor on the subject, was circulated and noted by the Committee :—

> "The most difficult question now is that of the selection of the settlers, and this will require very careful consideration by the Committee. No promises will be made to any East Indians until the final list giving all particulars regarding those proposed for selection are approved by me."
>
> F.G.G.
> 1.6.29.

The Immigration Agent General was asked to co-operate in this connexion by collecting and submitting names of suitable applicants for the Committee's consideration.

The Settlement Officer, Essequebo, was also instructed to furnish names of suitable East Indian families in Essequebo, including any of the present temporary tenants.

At the same time it was pointed out that it should be made clear that by collecting particulars of families did not necessarily mean that Government was under any obligation to settle them. As regards the agricultural experience of each family the Agricultural Superintendents of the Department of Agriculture were instructed to take steps to verify claims of applicants and to render all assistance to the Immigration Agents in their Districts with the selection of settlers.

20. *Pure Water Supply*—The Resident Engineer, Pure Water Supply Scheme, was co-opted as regards the drinking water supply, and a preliminary inspection of Bush Lot and the other Government owned properties was carried out by him.

It was decided, however, that actual operations should be held up until it could be definitely ascertained when the water would be actually required for the Settlement and other dependent areas in the vicinity. It was realised that when once a well had been sunk, there should be no interruption in its production of water.

21. *Legislation.*—A meeting of the Committee was held on August 21 to discuss the question of introducing legislation to apply to the Settlement as regards alienation, leasing and mortgaging, etc., and, after discussion, the acting Attorney General undertook to consider the drawing up of legislation to secure this. A Draft Bill was accordingly drawn up by him for consideration by the Committee, but the Committee came to the conclusion that the Bill needed certain modifications and that restrictions against alienation of land and property, leasing and mortgaging (except to an Agricultural Bank or Co-operative Society) and testamentary or intestate succession should be imposed and rigidly enforced, and drawn up during the period the first batch of settlers were renters.

22. *Despatch to the Secretary of State.*—A despatch was forwarded to the Secretary of State for the Colonies by His Excellency the Officer Administering the Government in November, setting out in detail the whole Essequebo Land Settlement Scheme and giving full particulars as regards expenditure in connexion therewith.

23. *Co-operation of Departments.*—In accordance with Governor's Memorandum No. 3 on the subject of the control of Colonization, the following departmental heads were co-opted during the year and gave the Committee advice and assistance :—

The Colonial Treasurer.
The Director of Public Works.
The Government Medical Officer of Health.
The Acting Attorney General.

The Immigration Agent General.
The Acting Commissioner of Lands and Mines.
The Acting Director of Public Works.
The Resident Engineer, Pure Water Supply Scheme.

Mr. Mullin, Commissioner of Lands and Mines, left the Colony on leave of absence and Major Craig, Director of Public Works, was appointed to act as a Member of the Committee in his absence, while the Conservator of Forests acted as Chief Colonization Officer during the absence of the writer in Canada.

24. *Accounting work in connexion with the Colonization Fund.*—The Colonial Treasurer assisted the Committee by advising as to suitable methods for controlling Colonization Fund expenditure and by drawing up tentative arrangements for the accounting work in connexion with expenditure on the schemes. It was realised that it was not possible to establish at the outset a comprehensive and analytical system of accounts and records, but this will be accomplished gradually.

The temporary accounting and statistical procedure suggested by the Colonial Treasurer was immediately adopted, but in order to relieve the Secretary of the extra work involved and to establish a kind of liaison officer between the Chief Colonization Officer and the Colonial Treasurer, the Accountant of the Agriculture Department (Mr. J. A. V. Bourne) was appointed to take charge of all accounting work.

25. *Miscellaneous.*—Apart from the two schemes referred to in this report the Committee considered various proposals for land settlement in other parts of the Colony, submitted from time to time. Several offers of land for sale by private individuals also engaged the Committee's attention during the year.

26. *Conclusion.*—The Colonization Committee realises that the Bush Lot Land Settlement, being the first scheme to be initiated, should be a complete success in every way ; and this, it is thought, can only be accomplished by the whole-hearted co-operation of the community.

A Financial Statement, showing expenditure from the Colonization Fund during 1929, is appended to this report (Appendix IV.).

J. SYDNEY DASH,
Chief Colonization Officer.

Department of Agriculture.
March 1, 1930.

APPENDIX I.

STATEMENT OF ESTIMATED EXPENDITURE AND ACTUAL EXPENDITURE TO DECEMBER 31, 1929.

	Estimated.		Cost to 31.12.29.	
Clearing Sand Reef	$ 500	00	$ 500	00
New Intake Koker at Lamaha Canal	350	00	501	08
Plank Weirs in Irrigation Canal	720	00	350	41
4,400 ft. Road	2,640	00	835	29
Bridge over main drainage façade trench .	600	00	353	69
Bridge over Navigation Canal ...	600	00	383	34
Bridge over drainage trench into village	737	00	163	05
9,000 ft. Cart track to Backdam	1,000	00	167	64
Converting lands into rice beds between reef and cross dam	1,775	00	2,883	08
Converting lands into rice beds (110 acres in old rubber cultivation)	4,200	00	3,679	96
Erection of 100 houses (61 built)	29,000	00	20,929	00
Levelling and grading house lots	1,200	00	1,186	22
Internal roads on reef ..	3,000	00	1,848	00
Fencing pasture	500	00	411	22
Cost of Survey and paaling off ..	421	15	172	97
Minor works and contingencies	1,095	85	110	02
Drainage and Irrigation Assessment		...	476	44
	$ 48,339	00	$ 34,951	41

APPENDIX II.

PRINCIPAL POINTS TAKEN INTO CONSIDERATION WITH REGARD TO THE PURCHASE OF PLNS. ANNA REGINA AND RICHMOND.

(i.) that Anna Regina, in view of its situation between the two Government-owned properties, viz., Bush Lot and Henrietta, would be a menace to the settlement scheme unless under the control of Government;

(ii.) that a Rice Mill, which was to be an essential feature of the settlement and which, in conformity with the proposed agriculture programme would be run on co-operative lines, was already installed at Anna Regina, in addition to other machinery units, electric light plant, etc.;

(iii.) that the additional area provided by the Anna Regina and Richmond Estates would allow Government to continue a programme of settlement alongside of Bush Lot; the latter serving the purpose of a demonstration settlement;

(iv.) that the Estate possessed much material which would be of use to the settlement including immigrant houses which could be pulled down and utilised at a later stage for extending the settlement if such a course was considered necessary ;

(v.) that Anna Regina held the key position with regard to the provision and distribution of irrigation water and a pure water supply to the whole district ;

(vi) that Anna Regina provided a convenient centre on the Essequebo Coast for locating the District Commissioner and associated officers ;

(vii.) that Anna Regina possessed numerous facilities as a central point for developing large scale co-operative enterprise among the Essequebo Agriculturists especially as regards rice, the main industry of the Coast ,

(viii.) that by extending the Bush Lot Settlement along the sand reef across Anna Regina with a single road system. public buildings, etc , the cost per acre would be reduced ;

(ix.) that it was most essential for the proper control of the drainage of the other Government-owned properties of Bush Lot and Henrietta for Government also to be in possession of Anna Regina. The acquisition of the properties being also necessary to assist in the establishment of a land settlement which had for its prime object the introduction of immigration and which *could not be successfully completed unless the drainage was effected through the Anna Regina main drainage sluice* ;

(x.) that by owning the properties of Bush Lot, Anna Regina, Richmond and Henrietta, comprising a total area of 2,687.15 acres, it was hoped in time to settle 6 or 7 community units of 100 families each, and to establish a township, self-contained with its drainage, and having a school, dispensary, hospital and market-place, as well as other conveniences. In addition there would be sanitation facilities and a pure drinking water supply.

APPENDIX III.

TERMS AND CONDITIONS FOR THE BUSH LOT LAND SETTLEMENT, ESSEQUEBO.

1. Each family will be allotted at first three acres of well irrigated and drained rice land. Extra land will be available to tenants proving themselves capable of efficiently working additional lots.

2. The period of rental, in the first instance, will be for a term of three years to enable the suitability or otherwise for permanent occupancy to be ascertained.

3. During the three year period of rental the following charges will be made :—

(*a*.) Annual land charge—$7 an acre, made up as follows .—

Rent	$4 00
Maintenance	2 00
Drainage Board Assessment ...	1 00
	$7 00

(*b.*) Annual rental for house and house plot, $18.

(*c.*) Annual pasturage charge per head of cattle, $2.88.

(*d.*) Annual sanitation rates, 75 cents.

4. The purchase price of the property at the commencement is fixed at $600, and when the three-year period of rental is about to expire, a tenant, if having shown proof of his ability to make full economic use of his land, may apply for, and will receive, the right to purchase his house, house plot and farm for a sum of $500 being the approximate value of the property less the amount paid in rent during the 3-year period of tenancy, on the following terms:—

(*a.*) Purchase price must be for whole property and not for house plot or cultivation alone.

(*b.*) Payment may be made in full or spread over a period of 12 years with interest at the rate of 6 per cent. per annum, plus maintenance rate ($2) and drainage board assessment ($1), which will be a perpetual charge.

(*c.*) Amount payable in rent for the first 3 years can be deducted from the total purchase price of the property.

5. No settler will be allowed to purchase his farm and house outright until he has been on the settlement for three years as a renter.

6. Any family joining the settlement after April 1, 1930, will commence the period of rental from the date of joining the settlement.

7. Repairs to houses will be borne half by the settler and half by Government.

8. Restrictions against alienation of land and property, leasing and mortgaging (except to an Agricultural Bank or Co-operative Society), and testamentary or intestate succession, will be imposed and rigidly enforced, and will be drawn up during the period the first batch of settlers are renters.

9. If a settler has not proved satisfactory after three years as a renter he will be called upon to vacate the settlement.

10 If a settler becomes objectionable in his behaviour, or is convicted of any serious criminal offence, he is liable to be ejected from the settlement.

11. Tenants and owners will be required to make punctual payment of rents, rates, and purchase money on penalty of deprivation of their rights to the land and buildings.

12. A rice mill will be operated near the settlement for the benefit of the settlers and will be run on co-operative lines, if a sufficient number require it. The Agricultural and Settlement Officers will be available to supervise and assist settlers in all matters appertaining to the cultivation and handling of their crops and stock.

APPENDIX IV.

EXPENDITURE FROM COLONIZATION FUND DURING 1929.

PROPERTIES.—				
Plns. Anna Regina and Richmond ...	$ 75,000	00		
Bush Lot	11,850	00	$ 86,850	00
ADMINISTRATION.—				
Remuneration to Chief Colonization Officer ...	600	00		
Remuneration to Accountant	240	00		
Salary—Typist	330	00		
Salary—Chemist-Ecologist	2,237	41		
Travelling—Chemist-Ecologist	492	75	3,900	16
MISCELLANEOUS.—				
Expenses, closing down Barbados Agency ..	56	85		
Expenses, collection of rice rents	40	91		
Insurance premiums Anna Regina Estate	143	56		
Stationery and printing	93	83		
Investigation of drainage at Bush Lot and Henrietta ...	111	60		
Rest house at Mabaruma	529	26	976	01
BUSH LOT LAND SETTLEMENT SCHEME.—				
New Intake koker at Lamaha Canal	501	08		
Plank weirs in Irrigation Canal	350	41		
Roads—4,400 ft of	835	29		
Bridge over main drainage façade trench	353	69		
Bridge over navigation canal	383	34		
Bridge over drainage trench into village	163	05		
9,000 ft. cart track to Backdam	167	64		
Converting lands into rice beds between reef and cross-dam	2,883	08		
Converting lands into rice beds at old rubber cultivation ...	3,679	96		
Erection of houses—labour (61)	4,339	13		
Erection of houses—material (61)	16,589	87		
Levelling and grading house lots	1,186	22		
Internal roads on reef	1,848	00		
Fencing pasture	411	22		
Cost of survey and paaling off	172	97		
Minor works and contingencies	110	02		
Clearing sand reef	500	00		
Drainage and Irrigation Assessment	476	44	34,951	41
MAINTENANCE ANNA REGINA AND RICHMOND.—				
Anna Regina—Staff	679	52		
Anna Regina—Contingencies	1,440	17		
Empoldering area factory and estates' houses ...	310	12	2,429	81
			$ 129,107	39

EXPENDITURE TEMPORARILY CHARGED AGAINST COLONIZATION FUND TO BE RECOVERED LATER ON.

Anna Regina- Block "A"	$ 13,500 00	
Henrietta	6,950 00	
Henrietta Seed Farm—conditioning	1,370 45	
Henrietta—Plank Weirs	193 48	
Henrietta—Minor Works	53 10	
Henrietta—Drainage and Irrigation Assessment	355 60	
Empoldering Block "A"	948 34	
Furniture, Settlement Officer's Quarters ...	510 75	
Reconditioning Commissioner's Quarters, Anna Regina	42 61	$ 23,924 33
Rice Mill—Anna Regina.—		
Working expenses	$ 994 47	
Purchase of bags	1,038 35	
Purchase of 4,273 bags paddy	7,178 64	
Insurance on paddy	60 00	9,271 46
		$ 33,195 79

REVENUE ADDED TO COLONIZATION FUND FROM ANNA REGINA AND BUSH LOT DURING 1929.

Bush Lot and Henrietta—rice bed rents	$ 629 07
Anna Regina - General revenue	143 50
Do. —Sale of machinery and scrap	2,812 95
Do. —Sale of livestock	1,584 00
Do. —Rice bed rents	997 86
Do. —Pasture and land rents	69 80
Do. —Electric light rents	48 20
Do. Sale of land	30 00
Rice Mill —Milling fees	35 77
	$ 6,351 15

OPENING OF THE BUSH LOT LAND SETTLEMENT SCHEME.

His Excellency the Officer Administering the Government, the Hon. C. D. Douglas-Jones, C.M.G., formally opened the Land Settlement Scheme at Bush Lot, Essequebo, on 7th May in the presence of a large gathering composed of members of the Executive and Legislative Councils, members of the B.G. Sugar Producers' Association, Government Officials, and other prominent citizens.

In opening the proceedings Professor Dash, Director of Agriculture and Chief Colonization Officer, said :—

Your Excellency and Gentlemen it gives me great pleasure as Chief Colonization Officer to welcome Your Excellency, members of the Legislative Council, and others interested in this Land Settlement Scheme here to-day.

As is well-known, the scheme in its present form was originated by the late Governor, Sir Frederick Gordon Guggisberg, and it is the irony of fate that he was not allowed to live to see these efforts and, need I state, the success so far achieved. It is no exaggeration to say that the eyes of the whole tropical world are turned towards this venture which is really an investigation of the problem of settling the coastal lands of the colony.

I should like to point out that the whole of the area you now see occupied, and the paddy field beyond, was once nothing but unoccupied jungle land ; and it is a great privilege to present to you these altered conditions with the development of a small township. These works were all outlined by the late Governor, and I have only been doing my duty, in collaboration with the Colonization Committee, in following meticulously the instructions laid down in his memorandum on the settlement scheme.

It is very gratifying to be able to inform Your Excellency that the whole of the settlement has now been allotted—85 families, in all 300 souls, from various parts of the colony. The number of applications has far exceeded the accommodation available. Although, as is evident all around, progress has been very marked. I should like to issue a clear warning that whether or not the scheme will be a final success can only be judged in the light of the experience gained, shall I say, at the end of four or five years. There are many difficulties ahead and for a scheme of this description to be firmly established the greatest possible care and guidance will be needed in the future. I am however, Your Excellency, fully optimistic for, with the keen and willing staff at my disposal, we as a Department intend to leave no stone unturned to see that this settlement which Your Excellency has kindly consented to open to-day will fully warrant the time and money spent on it.

His Excellency's Address.

His Excellency said:—

It gives me great pleasure to come here to-day to open this Land Settlement Scheme at Bush Lot, Essequebo. Before doing so, I should like to say something about this Land Settlement Scheme.

The problems of land settlement and colonization, which are often confused but which are quite different, have been matters which have received consideration from time to time in the past. Attempts at both have been made which have not proved successful, nor has it been possible to arrive at any definite proposals with regard to either of these problems.

Sir Gordon Guggisberg when he arrived in the colony took up the problem at the point it had then reached, and most of you are conversant with his memorandum on colonization and land settlement. I am sure that we all to-day regret that Sir Gordon is not with us and that he himself has not been able to open this settlement in which he took such a keen interest.

The chief need of British Guiana is population, and the kind of population we want for the development of this colony must be an agricultural one. This the late Governor emphasized in his annual Message to the Legislative Council in December 1928.

Briefly, then, the object of this experiment is to ascertain accurately the cost of settling people on the land and the possiblility of doing so with success. The cost will be much the same whether the people are settlers or colonists, except that in the latter case there would be the cost of the journey here. This cost would not, most probably, be borne by this colony. The procedure is to build houses and to prepare the land ready to receive crops. Families are selected to occupy the houses and take up the land which has been prepared. In this particular case, as this land is most suited for rice growing and, as the East Indian population of this colony are mainly engaged in rice growing, the settlement has been made an East Indian one, but if this prove a success, and I have no doubt that it will, more settlements will be established. The Government is very satisfied with the number of applications which have been received, and I am sure that if we can get permission to spend money on developing other properties on the same lines as we have done this one, we shall have no difficulty in getting the right sort of people to take up allotments from both the Negro and East Indian populations.

Increasing Farming Activity.

I have appointed a Committee to investigate the question of increasing farming activity among the peasant population, and when its report has been received I have no doubt that consideration will be given to the question of establishing similar settlements for other sections of the population of this colony on land which will be suitable for the growing of such crops as these people are in the habit of

cultivating. A crop which would, I think offer the largest scope would be sugar-cane, and I hope that it may be possible to devise a scheme for the establishment of cane farming communities in spite of the fact that attempts in this direction have failed in the past. These communities would have to be established in the neighbourhood of sugar factories so that the canes could be transported and sold to the factories. I do not propose at this moment to go further into details, but I only mention this as an indication of what it is hoped this experiment may show to be possible. In this connection Sir Gordon said "that this Government will be failing in its duty to the country if it deferred any longer the actual initiation of those investigations and preparations which are essential to the execution of a Colonization Scheme." It is, therefore, with these ideas in view that the Bush Lot Land Settlement Scheme has been initiated and, if this experiment is a success, it will open the door to colonization and attract communities of the best agricultural peoples from neighbouring colonies. Of one thing I am quite certain, and that is that if we all work together, any sound scheme, either of colonization or land settlement will be a success.

GRATIFYING DEVELOPMENT.

I, personally, have been very interested in watching the development of this scheme, and the successful manner in which it has been launched is most gratifying. As stated by Professor Dash in his opening remarks, all available land has now been taken up and further applications which have since been received have been noted on a waiting list in order to fill up any vacancies that may occur. It is early to say how this scheme will eventually develop, and it must still be looked upon in the light of an experiment. I wish, however, to inform the Agriculture Department, in whose hands the guidance of this scheme has been placed, that Government will give that Department every possible assistance in order to ensure its success.

ADVICE TO SETTLERS.

I should like now to address a few words to the settlers themselves. In the first place, I must congratulate you on having been chosen as the first settlers on Bush Lot, and I consider you are very fortunate in having been selected. It must be your duty carefully to follow the terms of the lease which you will be called upon shortly to sign, and also to follow the instructions given to you by Mr. Frampton, the Agricultural Officer who will be placed in charge of you. I would, however, warn you that if there is any neglect in the cultivation of your plots or failure to carry out the terms of the lease which has been specially drawn up to meet your requirements, you will not be allowed to stay here. If, on the other hand, you make every effort to carry out these conditions, I can give you a guarantee that you will be unmolested and eventually you will be able to purchase the houses and allotments. You have your houses and gardens, you have your 3 acres of rice land, and you have pasturage for your cattle. The rates which it is

proposed to charge to cover the cost of irrigation, drainage and other works have been fixed as low as is thought possible to make them. In fact, we are satisfied that the proposition which the Government has been able to offer to would-be settlers is an attractive one, and that you have found it so is proved by the number of applications we have received.

The Director of Agriculture and his Deputy, Mr. Burnett, and Mr. Frampton, the Agricultural Superintendent of this district, are going to pay very special attention to your interests. The Department of Agriculture will supply you with the very best seed that can be grown in this colony, and if you will only follow the advice of the Officers of that Department and grow your crops as they should be grown, the paddy which you will produce will always be saleable at a good price. You all know Mr. Burnett and you know that he has just come from Ceylon where he has assisted people of your own race in that colony. He understands all about co-operation, co-operative finance and co-operative marketing of the crops which you will produce, and I feel quite certain that, if you will listen to what he tells you and carry out his advice, in a very few years you will all be quite rich.

CREDIT SOCIETY AND RICE PLANT.

It is hoped in the course of time to start a Co-operative Credit Society in your midst and also a Co-operative Rice Milling Plant for your use.

When, however, you have any difficulties or troubles you have only to represent them to Mr. Frampton or to Mr. Burnett, and I feel quite sure that they will be able to smooth them all away.

I wish you all the best of luck and with hard work and diligence I feel certain you will make this Bush Lot Settlement Scheme a successful one, and I hope that you will become a happy, united, and prosperous family.

I must take this opportunity of expressing my own personal thanks and the thanks of the Government to all those who have worked so hard in the preparation and the development of this scheme and specially to mention, in addition to Professor Dash, Director of Agriculture and Chief Colonization Officer, the names of those who have served on the Colonization Committee: Mr. Wood, Conservator of Forests; Mr. Mullin, Commissioner of Lands and Mines; Mr. Thompson King and Major Craig, Director of Public Works. To that Commitee must be given all credit for having brought this scheme into fruition.

Then there is Mr. Nightingale who, as Settlement Officer, was especially sent here to take charge of the building of these houses, the preparation of the land and the re-construction of the necessary drainage and irrigation. Mr. Nightingale is to be congratulated on the great amount of work he has done at such a low expenditure of money. We are also grateful to the Director of Public Works and his Assistant, Mr. Livingstone, who was, until he left the colony, mainly concerned with the problem of draining Anna Regina and the adjoining proper-

ties; also to Mr. Hill of the Immigration Department and Mr. Burnett, Deputy Director of Agriculture, both of whom have rendered valuable service in connection with the selection and settling of the families; and finally Mr. Frampton, Agricultural Superintendent, who has attended to the Agricultural details.

I now have great pleasure in declaring this Settlement open.

"Rain" Tree Planted.

His Excellency then cut a tape from across the bridge at the southern end of the main road of the compound which he afterwards crossed and expressed the wish that the scheme would be a long-lived and successful one. At the southern end of the road His Excellency planted a small "Rain" tree to commemorate the ceremony.

Demonstration to the West Indies.

Hon. R. E. Brassington, in moving a vote of thanks, on behalf of the people of Essequebo, to His Excellency for performing the ceremony, said he was sorry the weather had been so unkind that afternoon. He thought, however, that it would take a great deal more than unkind weather to damp the enthusiasm of the people of Essequebo with regard to land settlement. His own convictions were varied as regards the scheme in question. As most of them knew, he was manager of the property for a period of twelve years and his mind went back to the time when it was an area of smiling cane-fields. Unfortunately cane had gone out, but he hoped that their rice-fields would bring them more prosperity than cane had done. The success of the scheme lay with the settlers, assisted by Government, and that success spelt hard work. Government and the taxpayers had spent a large sum of money in an attempt to demonstrate not only to the people in the colony, but also to those in the West Indies, that they could settle people on the land and that they could earn a profitable living thereby. Both Professor Dash and His Excellency had laid stress on the various problems which had to be tackled to bring about the success of the scheme and he therefore took that opportunity of drawing His Excellency's attention to the drainage of the north end of that coast. The people of Essequebo wanted to see their Governors visit Essequebo more frequently and he would also like to see more legislators so that they could see things for themselves.

Plea for Better Drainage.

He referred to the fact that several places including Land of Plenty, Mainstay and Three Friends were under water that day, adding that he was sorry the land settlement scheme was not further away so as to give them better opportuni-

ty of seeing the miserable conditions of drainage in Essequebo. He implored His Excellency on behalf of the people there to take steps for putting down a few pumps in order to improve the situation. It was not only his view, but also that of other experienced planters, that they would never have good drainage there until they had a few pumps installed. The small plot on which the land settlement was situated was drained then, but that did not represent Essequebo as a whole. He therefore hoped His Excellency would do something for the improvement of the other parts of the Coast when he returned to the city. Government had done something with regard to the scheme for which they deserved to be congratulated. On behalf of the people of Essequebo he thanked His Excellency for opening the scheme and also for the interest he had taken in it since its inception.

A "PLUMB-EYED" SCHEME.

Hon. S. H. Seymour, proprietor of Pln. Taymouth Manor, welcomed the strangers on behalf of the people of Essequebo and expressed the conviction that the scheme would be a success. He had seen a super-caustic critic in one of the daily papers a few days ago describing the scheme as a "cock-eyed" one, but he saw nothing "cock-eyed" about it. In his opinion it was a "plumb-eyed" scheme and he advised the settlers to get down to real hard work and they would not only succeed but help the colony as a whole to progress. They should cut out all politics and "playing to the gallery" as they were not wanted in Essequebo and would do nothing for them. So long as they would not get down to real hard work in industries in this colony, so long would they remain poverty-stricken, and he assured them that as long as they got down to bedrock with that hard work, he was there to do all he could for them in order to make the scheme a success.

AGRICULTURAL COMPETITIONS.

During 1930 Agricultural Competitions will be held for the following :—

1. The best blocks, of not less than 1 acre, of transplanted paddy in the districts named below :—
   - (a) West Coast, Demerara.
   - (b) Upper Corentyne.
2. The best blocks, of not less than half an acre, of pure line paddy, which must be grown from selected seed supplied by the Department, in the districts named below :—
   - (a) Essequebo.
   - (b) E.C. Demerara, between Kitty and Mahaica and between Mahaica and Abary.
3. For the best pruned and drained blocks, of not less than 2 acres, of coffee in the districts named below :—
   - (a) West Coast, Demerara.
   - (b) North Western District at Koriabo, Aruka, Barima, Mora Passage and Imbotero Creek.
4. For the best miscellaneous farms, of not less than one quarter of an acre, in the districts named below :—
   - (a) Essequebo, between Affiance and Richmond.
   - (b) E.B. Berbice River, between New Amsterdam and Mara.
5. The best 3-acre paddy block on the Bush Lot Land Settlement area.
6. The best miscellaneous garden on the Bush Lot Land Settlement area.

Details of the prizes offered and of the rules governing these competitions can be obtained from leaflets which have been distributed by the Agricultural Superintendents in the several districts named.

J. S. D.

NOTES.

Sugar Notes—*Sophia Experiment Station*—The British Guiana Sugar Planters' Experiment Stations Committee, a number of prominent Planters and several Officers of the Department of Agriculture visited the Sophia Station on March 24, 1930.

The party devoted several hours to going around the fields, inspecting the experiments, buildings, etc. A good deal of interest was aroused by the preliminary experiment on underdrainage with bamboos, and a useful and lengthy discussion took place as to the true cause of the remarkable and obvious difference in favour of the underdrained plots. There seems little doubt but that much of the increased growth in these plots is due to the water taken into the small open drains during dry weather being immediately carried under the beds in the case of the underdrained plots and thence by capillarity to the roots, whereas, in the control plots, water from the small drains must work its way into the bed laterally for a distance of some 17 feet, a slow, if not impossible process with our compact soils.

The green manure plots were inspected and the merits of the different varieties discussed. In this connexion special emphasis was laid on the vigour of the Black Bengal Bean (*Stizolobium atterimum*) and its power to come up through a crop of weeds and eventually smother a field completely.

The variety experiment in Field 13 West and the fertilizer and liming trials in Fields 17 East and 12 West, respectively, were also visited and the method of experimentation explained.

Heaps of cane trash and of rice straw which are being broken down by the Adco process to form synthetic farmyard manure were inspected and the method of preparation, etc., detailed.

In connexion with this visit of the Planters, the Chemist-Ecologist had prepared a note on manurial experiments which have been or are to be undertaken, and the Agronomist had prepared a Progress Report in which he dealt mainly with the work on varieties and green manures and the production and testing of new seedlings. The memoranda had been circulated before the meeting and the numerous points raised were keenly discussed both during the tour of the fields and at a formal meeting of the Experiment Stations' Committee held immediately after.

One of the main results of the discussion has been the starting of a large and complex manurial trial at Sophia with D. 625 as an indicator. Powdered limestone at the rate of 1.5 times the theoretical lime requirement; Nitrogen, as sulphate of ammonia, at 40, 80 and 120 lb. per acre; potash, as sulphate of potash,

at 150 lb. per acre; Phosphates, as Superphosphate and as ground Buccaneer rock phosphate, at the rate of 150 lb. P_2O_5 per acre, are all compared with each other and against mixtures of any two or three, in all possible combinations. Each of the 32 possible treatments appears four times, and the experiment has been so laid out as to permit a mathematical interpretation of the data obtained. Thanks are gratefully extended to Plantations Providence, La Bonne Intention, Ogle, Enmore, Non Pareil and Lusignan for supplying the large number of 625 plants required for this experiment.

The planting of the variety trials on the estate sub-stations has entailed a heavy distribution of planting material from Sophia, and the total distribution for the half-year will probably reach 70,000 plants.

Sub-stations and Estates.—Manurial trials have been laid down at Hampton Court, Uitvlugt and Blairmont on acid "front land" soils. The indicating variety in each case is D. 625. The experiments are all of the "Latin Square" type and seek to determine :—

(a) The relative values of 40, 80 and 120 lb. nitrogen per acre as sulphate of ammonia.

(b) The relative values of Kerazotine, Leathermeal (two nitrogenous organic manures) and sulphate of ammonia at equivalent doses of nitrogen.

(c) The effect of splitting the dose of sulphate of ammonia in two applications and of adding phosphates and/or potash.

Ere this appears, variety trials will have been established at Diamond, Uitvlugt, Blairmont, Lusignan and Port Mourant. The system of experimentation adopted is the "randomized block" method and the varieties used are promising selections of those created at this Station together with B. H. 10 (12) and S.C. 12 (4), and D. 625 as a standard.

Variety trials at Blairmont :—Mr. Bolin, Chemist at Plantation Blairmont, has very kindly communicated the results of some valuable variety trials he has carried out on that Estate. The figures given are for Plants and First Ratoons in Field B. K. 27, an old heavy "front land" field, and for Plant canes from Field R. P. 17, a lighter "back land" field of a peaty nature. With regard to the plant cane results from B. K. 27 it should be remarked that the field did not receive normal attention. The most that can be said is that all the canes suffered from the same disabilities. The ratoons were normally cared for and did much better. In all cases the figures given are the means of several scattered plots, the "lb. sucrose per gallon" of juice is the analytical figures from hand-mill juice less 0.45 lb. per gallon, and the purity is that of the hand-mill juice reduced by 7.0.

VARIETY TRIALS AT PLANTATION BLAIRMONT (D.C. BOLIN).

Variety	Normal Juice		Tons per Acre	
	Sucrose lbs. per gal.	Purity	Cane	Sugar
FIELD B.K. 27: PLANT CANES.				
Xa	1.61	81.4	27.73	2.88
D683	1.67	82.8	37.04	2.87
Xb	1.76	81.4	28.30	2.65
D747	1.80	84 8	21.30	2.62
D666	1.46	78.6	27.35	2.62
D695	1.73	79.8	23.70	2.58
D331	1.82	83.0	19.90	2.51
D625	1.60	80.0	22.90	2.36
D195	1.82	81.5	20.33	2.36
B247	1.57	83.6	23.00	2.34
D447	1.74	80.8	20.40	2.33
D203	1.67	80.4	19.31	2.08
D642	1.55	81.3	20.50	2.05
D231	1.63	81 0	19.05	2.03
D50	1.67	81.2	18.40	2.00
FIELD B.K. 27: 1ST RATOONS.				
D695	1.477	84.13	33.25	3.50
D636	1.388	81.81	30.87	2.97
D195	1.551	81.63	28.08	2.90
Bx	1.420	82.93	28.48	2.85
D666	1.320	80.18	32.05	2.81
D663	1.418	80.55	28.84	2.77
D625	1.423	81.25	27.32	2 66
D684	1.162	78.08	29.50	2.53
UBA	1.162	77.32	38.10	2.53
D490	1.430	82.00	25.32	2.50
D671	1.384	82.10	26.04	2.50
FIELD R.P. 17: PLANT CANES.				
D351	1.643	84.27	44.35	5.12
D747	1.500	83.35	40.66	4.46
D625	1.562	82 08	37.78	4.15
D707	1.292	78.72	43.88	4.14
D507	1.390	79.00	41.78	4.06
XB	1.650	81.37	34.76	3.94
D663	1 456	80.57	36.74	3.92
D695	1.585	82.81	34.58	3.89
D684	1.211	77 44	42.54	3.88
D642	1.548	79.92	35.86	3.85
D554	1.427	81.22	37.98	3.84
D106	1.365	79.04	37.10	3.65
D490	1.544	83.63	31.70	3.60
D671	1.546	84.20	30.98	3.59
D83	1.404	83.51	34.15	3.56
D733	1.594	81.70	32.53	3.54

C.H.B.W.

To make Cassava Farine. The tuberous roots of the cassava are scraped, washe d, so as to remove the skin &c., and grated. The last operation is sometimes performed with a hand-grater but can be accomplished with a mill constructed for the purpose. The grated cassava is either wrung in bags by the hand, or the bags placed in a press, which is made so as to express as much of the juice as possible. After the last operation the cassava contained in the bags will be found to be damp and inclined to be lumpy, therefore, before sieving, it should be put in the air or sun for a short time. Any piece of cassava sieved out may be grated and passed through the sieve with the next lot of grated cassava. An open, flat iron pan will be found most convenient in which to heat the cassava, which should be placed in the pan and the heat gradually applied. The amount put in should not be deeper over the bottom of the pan than one inch. The cassava must be stirred continually so as to prevent local over-heating.

The colour of the cassava begins to change after the first ten minutes from white to a light creamy colour and goes on changing until the cassava is sufficiently cooked. The time taken altogether is about forty to forty-five minutes, depending on the dryness of the cassava and the amount placed in the pan. The taste and the texture of the farine are important factors in determining the time for removing it.

In making a large quantity of farine the pan must be allowed to cool before it is refilled, as a hot pan causes the slightly damp cassava to lump. It is advisable that stirring should be kept up as long as there is any cassava in the pan. After the farine has cooled, it loses some of the creamy colour and is nearly white. The texture of the finished farine will, in a great measure, depend on the diameter of the meshes of the sieve used, and on the dryness of the cassava when placed in the pan.

J. S. D.

Green Manuring of Coconuts.—Leaflet No. 57 of the Department of Agriculture, Ceylon, (reprinted in the Tropical Agriculturist, LXXIII, No. 3 p. 144 1929) deals with 'Green Manuring with particular reference to coconuts'. The account is based upon the methods generally employed in the East, but much of the information contained in it is of universal application. After defining green manuring as 'the practice of incorporating in the soil undecomposed plant material with the object of increasing soil fertility' the advantages of such a practice are enumerated. These include protection of soil from washing away and leaching by heavy rains, also from the mechanical beating action of rain, and from the excessive heat of the sun. Ploughing in of green manures increases the content of soil humus, and humus has many valuable properties. Amongst others it absorbs water and mineral constituents of the soil and regulates their supply, improves the texture of the soil, and stores its nitrogen. Furthermore, the micro-organisms which are the life of the soil depend on it for their existence. Green manuring reduces weeding costs, and supplies the suface soil in a quickly available form with plant food constituents obtained from the soil and subsoil. It improves the aeration of the soil and finally, most important of all, increases the amount of nitrogen in the soil considerably. In addition, the foliage of many green manure plants can be used as fodder.

The practical side of the question is considered at some length. As a general rule green manures should be cut towards the end of the wet season, and turned in when the soil is still moist. On no account should they be cut and forked in during dry weather. Green manures can be very profitably employed, where rainfall is sufficient, upon poor sandy soils, and in this case should be of the quick growing annual variety. Where perennials are used as green manures, they should not be allowed to grow for too long without being ploughed in.

Mention is then made of a number of varieties of green manure crops, several of these being referred to in some detail. Of the twining and creeping varieties *Vigna catiang* (Cow Pea) is found to thrive well on poor land and to withstand drought, and *Dolichos hosei* is suitable where shade is heavy. *Phaseolus lunatus* (the Lima bean) is largely employed in the Philippines. Of the bush varieties of green manures, species of *Tephrosia* and *Crotalaria* are found most suited to coconuts.

During prolonged periods of drought, most cover crops die down, the decayed material forming a good mulch, which may be assisted by occasional light harrowing. In cases of covers which stand drought well however, it has been found in Ceylon that once these are established, less moisture is lost from the covered area than from bare soil.

E. B. M.

DEPARTMENTAL NEWS.

His Excellency the Officer Administering the Government, the Hon. C. D. Douglas-Jones, visited the Stock Farm, the Sugar Experiment Station, Sophia, the Rice Experiment Station, Demerara, and the Botanic Gardens on Friday, March 28. His Excellency also visited the Head Office of the Department on Saturday, April 12.

The Director paid visits of inspection to the Essequebo Coast, and the East and West Coasts, Demerara.

The Bush Lot Land Settlement Scheme was officially opened by His Excellency the Officer Administering the Government on Wednesday, May 7. The Director, who is Chief Colonization Officer, the Deputy Director and other members of the staff were present.

The Deputy Director visited the Essequebo Coast on several occasions with special reference to the Bush Lot Land Settlement Scheme. Circuits of inspection were also made in the following districts:—Pomeroon, Berbice, Corentyne, East and West Coasts, Demerara.

Definite arrangements have been made for pure line paddy trials to be carried out on ten-acre blocks at Pln. Rose Hall, Canje, Berbice, Pln. Port Mourant, Corentyne, and at the Experiment Station, Henrietta, Essequebo.

Mr. W. E. K. Baron Van Lijnden, officer of the Agricultural Experiment Station, Paramaribo, arrived in the Colony on March 10 to study cultural methods with special reference to rice. He visited the Rice Experiment Station, Demerara, and was given every facility for studying local problems.

On March 27 the Rice Committee at the Chamber of Commerce appointed a sub-committee, with the following personnel, to enquire into, and draw up regulations for, the grading of rice:—Prof. the Hon. J. Sydney Dash (Chairman), Messrs. T. R. Cowell, H. B. Gajraj, and F. Burnett (Hon. Secretary).

Three meetings have since been held and a report together with recommendations have been submitted to the Chamber of Commerce.

Professor James G. Needham of Cornell University, Ithaca, U.S.A., arrived by the Pan-American Air Mail on April 9 and left the Colony on April 16. He was specially interested in collecting local specimens of Odonata and was accompanied by Mr. Cleare, Government Entomologist, on a number of his excursions. Professor Needham's work on 'General Biology' is still a standard text-book in many Universities.

Professor F. Hardy, Professor of Chemistry and Soil Science at the Imperial College of Tropical Agriculture, arrived in the Colony on April 16. Visits were made, in company with Mr. Follett-Smith, to Plns. Ogle, E. C. Demerara, Providence, E. B. Demerara, Bartica, Saxicalli, Wolga, the Penal Settlement, Plns. Bath and Blairmont, Berbice, Christianburg and Akyma. In most instances the soil types were inspected and samples collected.

In addition to the above-mentioned activities Mr. Follett-Smith, the Chemist-Ecologist, visited Pln. Enmore on March 6, Pln. Anna Regina *cum annexis* from March 11—22 in connexion with soil surveys, Pln. Ogle on March 27, Plns. Blairmont andRose Hall on April 5—7, and Pln. Lusignan on May 2.

Mr. L. D. Cleare, Government Entomologist, visited Pln. Providence, E. B. Demerara, and the West Bank, Demerara, on March 12 and 27 respectively. He also visited Plns. Letter T., Park and Drill in the Mahaica-Mahaicony District on April 4 and 11 in connexion with an outbreak of the Coconut Caterpillar.

On May 19 Mr. Cleare left for England on six months' leave of absence.

Major T. Bone, Government Veterinary Surgeon visited Essequebo from March 4—8 in connexion with sickness among calves at the Onderneeming Industrial School, and visited Mahaicony on April 29 with reference to an outbreak of Anthrax.

A Conference of Staff Officers was held at the Head Office on April 22. On April 23, the District Agricultural Superintendents visited the Sugar Experiment Station, the Rice Experiment Station and the Stock Farm, and fully discussed, with the officers-in-charge at the respective stations, the problems under investigation.

Mr. E. B. Martyn, Botanist and Mycologist, visited Berbice, from April 8—11, inspecting farms in company with the Agricultural Superintendent, Mr. H. Macluskie. Visits have also been paid to the East and West Banks, Demerara River, in connexion with the Wilt Disease of plantains and bananas, and to Christianburg, April 26—28, to carry out investigations on the cultivation of Crowa (a variety of pineapple from which fibre is obtained).

Mr. C. L. C. Bourne, Assistant Chemist, and Secretary of the Sugar Experiment Stations' Committee, left the Colony on Monday, May 19, on 6 months' leave of absence. During this period Mr. J. F. Irving will act as Secretary to the above mentioned Committee.

During the period January to May, the Sugar Cane Agronomist visited Plns. La Bonne Intention, Wales, Lusignan, Schoon Ord, Versailles, Lochaber, Bath and Hampton Court, and went over the cultivation, seedling nurseries, etc. Four days were spent at Blairmont, one at Uitvlugt, and six at Hampton Court in connexion with manurial experiments which have been established at these places. Five visits were paid to Diamond and a variety trial established. Port Mourant was visited, May 5, 12-17, in connexion with a variety trial, which has been started there. On several of these visits soil samples were taken.

The Experiment Stations' Committee and a number of planters visited the Sugar Experiment Station, Sophia, on March 24, and several other visitors have been shown around from time to time. Among the latter were Sir Alfred Sherlock, Colonel I. Davson, Mr. T. Maylor and Professor F. Hardy.

Messrs. G. E. Anderson, J. C. Gibson and C. Farrar, members of the Sugar Experiment Stations' Committee, have left for England on furlong ; during their absence from the Colony the vacancies on the Committee will be filled by Messrs. R. P. Daggett, D. Clarke, and A. Waterfield.

PLANT AND SEED IMPORTATIONS.

THE FOLLOWING ARE RECENT INTRODUCTIONS BY THE DEPARTMENT OF AGRICULTURE.

DESCRIPTION	QUANTITY	WHENCE RECEIVED
Economic.		
Tobacco Seeds—Common Type	1 Packet	A. L. Baker, Ponta Delgada, Azores
„ „—Superior Type	1 „	St. Michel, Azores
Sugar Cane, Ba. 11569	6 Cuttings	Department of Agriculture, Trinidad
B. 417	6 „	„
B. 726	6 „	„
CO. 210	6 „	„
CO. 213	6 „	„
CO. 281	6 „	„
CO. ?	10 „	Martinique
P.O.J. 36	10 „	„
P.O.J. 253	10 „	„
Martinique ?	12 „	„
Ornamental.		
British Honduras Mahogany	600 Seeds	Department of Agriculture, Trinidad.
Cinchona Ledgeriana	1½ ozs. Seeds	Government Cinchona Plantation, Kalempong, Bengal, India.
Amherstia nobilis	1 Seed	Royal Botanic Gardens, Trinidad.

EXPORTS OF AGRICULTURAL AND FOREST PRODUCTS.

Below will be found a list of the Agricultural and Forest Products of the Colony exported during the first quarter of 1930.

The corresponding figures for the same period during previous years and the average for the twelve years prior to that are added for convenience of comparison.

Product		*Average 1916-27*	*1928*	*1929*	*1930*
Sugar	tons	19,470	26,104	19,470	12,350
Rum	proof gallons	699,760	430,223	265,462	303,491
Molasses	gallons	104,697	515,503	1,061,117	914,083
Molascuit	tons	401	626	459	332
Rice	tons	2,841	4,150	4,461	5,693
Coconuts	thousands	643	72	79	163
Coconut Oil	gallons	6,451	6,813	4,965	6,572
Copra	cwts.	2,814	13,893	25,967	15,226
Coffee	cwts.	2,106	3,573	4,386	247
Lime Juice Concentrated	gallons	326	None	None	330
Essential Oil of Limes	gallons	17	None	None	None
Rubber	cwts.	38	70	None	46
Balata	cwts.	2,413	1,052	864	1,603
Gums	lbs.	1,056	608	None	None
Firewood—Wallaba, etc.	tons	2,022	3,369	2,335	2,869
Charcoal	bags	10,976	11,533	15,000	12,740
Railway sleepers	No.	5,229	2,614	6,869	3,369
Shingles	Thousands	406	491	824	519
Lumber	ft.	50,066	45,213	49,779	27,187
Timber	cu. ft.	34,895	33,861	66,505	49,651
Cattle	Head	100	5	19	638
Hides	No.	1,684	2,465	2,076	1,494
Pigs	No.	124	None	61	289
Sheep	No.	4	65	None	2

CURRENT PRICES OF COLONIAL PRODUCE.

From The Commercial Review, Journal of the Georgetown Chamber of Commerce, Vol. XIII, No. 11, May, 1930.

SUGAR.

Per 100 lbs. net 3 lbs. per Bag allowed for tare

Dark Crystals for Local Consumption..................$2.80
Yellow Crystals do. do. $3.40
White Crystals..$3.60
Molasses Sugar...... ....none offering

RUM.

Imperial Gallon. Cask included.

Coloured, in Puncheons—40 to 42 O.P...(for export).....60c. Hhds. 65c. Barrels 70c.
White, in Hogsheads—10 to 45 O.P....(for local consumption)...........48 to 50c.

MOLASSES.

Per Imperial Gallon. Cask included.

Yellow (firsts).. }
Yellow (seconds).. } None Offering
Dark......................... .... }

RICE.

Rice............per Bag of 180 lbs. gross, $3.80 to $5.00 as to quality.
Paddy..........per Bag of 143 lbs. gross, $1.32 to $1.50

GENERAL.

Timber, Gr. Heart, (Lower grade measurements)...72c. to 96c. per c. ft., for export $1.00 to $1.20 per c. ft.
Do. Railroad Sleepers—(Mora)...$1.68 each
Greenheart Lumber..$110 per 1,000 feet
Crabwood Lumber ....$60 to $75 per 1,000 feet
Shingles, Wallaba, 4 x 20 and 5 x 22 inches,......................$7.00 to $9.00 per M.
Charcoal, Capped for shipment................ . ...$1.00 to $1.20 per Bag
Firewood ....$3.00 to $3.50 per ton
Coconuts........ Selects, $18.00, culls......$10.00 M . ...Copra, 3½c. per lb.
Balata... ....Venezuelan, none. Local Sheet...38 to 40 cts. per lb.
Cocoa.......... ....14c. „ „
Coffee...7c. „ „

N.B.—Duty payable on value at time of Importation and at Rate of Exchange on day of arrival.

METEOROLOGICAL DATA—JANUARY—MARCH, 1930.

Recording Stations & Months.	Rain-fall. Total Inches	NUMBER OF DAYS OF RAIN: Under ·10 Inch	·10 to ·50 Inch	·50 to 1.00 Inch	1.00 Inch to 2.00 Inches	Above 2.00 Inches	Total days.	Evaporation. Inches	Air Temperature and Humidity. Air Temp. Maximum.	Minimum.	Mean	Humidity. Mean
Botanic Gardens.												
January ...	8·24	5	17	.	2	1	25	3·86	82·2	74·6	78·4	84·8
February ...	3 70	8	5	1	1	...	15	5·18	82·9	74·7	78·8	79·2
March ...	1 10	7	5	...	...	...	12	6·76	84·5	75·9	80·2	78·9
Totals	13·04	20	27	1	3	1	52	15 80				
Means	..	.	. .	...	...	..	...	...	83·2	75·1	79·1	80·9
Berbice Gardens.												
January ...	8 32	10	11	3	1	1	26	...	83·9	73·5	78·7	83·6
February	0 92	11	2	.			13	..	85·1	74·1	79·6	77·6
March	2 62	4	3		1	.	8	...	86·8	74·8	80·8	76·4
Totals	11 86	25	16	3	2	1	47	...				
Means.		.	..	...					85·3	74·1	79·7	79·2
Onderneeming.												
January	13 16	1	12	3	5		21	.	85·2	73·7	79·4	84 2
February	3 36	...	7	2	1		10	..	86·2	74 7	80·4	82·9
March	1·89	2	7	...			9	..	86·7	74 8	80 7	82 4
Totals	18 41	3	26	5	6		40	..				
Means.	...		.		...	..	...	...	86 0	74·4	80·2	83·2
Morawhanna, N.W.D												
January	9 44	2	15	3	1	1	22	...	...	.	...	..
February .	4·19	1	8	3			12		.	..	...	.
March	2·30	1	9	1	..		11	...	...	...	...	..
Totals	15·93	4	32	7	1	1	45	...	...	...	..	...

Vol. III No. 3. September 1930.

The Agricultural Journal of British Guiana

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Field Assistant	L. A. Forte
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In collaboration with the Officers of the Department of Agriculture.

CONTENTS.

(Vol. III, No. 3.)

LIST OF ILLUSTRATIONS.

MESSAGE FROM HIS EXCELLENCY THE GOVERNOR TO THE AGRICULTURISTS OF THE COLONY.

I have been asked to give a message to the agriculturists of the Colony through this Journal. At such a period as this, when we are faced with agricultural depression in so many directions, when our main products are suffering from the lowest prices which they have reached in their history, when we are participating in the world depression, any helpful message I can give must necessarily be one of hope for the future based on confidence in the cultivators and cultivations of this Colony.

It has been my good fortune to spend thirty years of Colonial service in Colonies which have depended primarily upon agriculture for the social and material progress of their inhabitants and in each of these countries periods of most serious depression have occurred and at the present time they are all,—Ceylon, Mauritius, East and West Africa,—passing through periods as critical and as trying as that which British Guiana endures to-day.

Such periods should undoubtedly be used as stock-takings in the agricultural history of the country. Depressing as they may be at the time, they serve as useful lessons of the dangers of too great a reliance on a particular crop, of the urgent need of scientific development and experiment in all directions, and of concentrated effort and increased knowledge on the part of the cultivators.

In this Colony to-day, the sugar depression is forcing us to examine more closely the costs of output, the overhead expenses incurred and the need for economies in many directions. It is also forcing all growers to look to hitherto unutilised lands as potential sources of development. Alternatives to our main crop which have hitherto been only experimented with are realised now as urgent necessities to secure the means of livelihoood.

In rice, it behoves us to secure outside markets and to this end Grading Regulations have been introduced which will, it is hoped, ensure for Demerara Rice a market secured on its quality not only in the Caribbean Sea, but on the Continents of North and South America.

The depression in sugar must necessarily overshadow all other falls in price and depreciations in value in other products. Unhappily, it is associated with falls in the price of copra and coconuts and coffee. A committee has been appointed dealing with the position in regard to the last named cultivation and we may reasonably hope that better prices are bound shortly to be reached.

It is unwise as well as commercially bad policy to stress the state of depression at the present moment. It can only have the effect of creating despondency and even doubt in the minds of those who are not so thoroughly acquainted with actual conditions in the Colony and its sources of wealth as are its inhabitants. Let us remember that the export figures for rice reached their highest point in 1928 and there is every sign of further expansion of the industry while the export of coconut products in 1929 was nearly twenty times that of ten years ago and even in sugar our exports are considerably larger than they were a decade back and the returns per acre are now larger than at any previous time. The land has not failed us. Let us see to it that we do not fail the land we live in.

Edward Denham.

Governor.

September, 1930.

The

Agricultural Journal of British Guiana.

September 1929

ERRATA.

THE AGRICULTURAL JOURNAL OF BRITISH GUIANA.

Vol. III.—No. 2.

Page 79 line 11—*Read* 0.8025

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14—*Read* 4828^2 +......+......) ÷ 5

17—*Read* 4727^2 +......+......) ÷ 5

... will be sufficient to pay capital costs and maintenance charges.

Few, if any, of these crops have been introduced with less acclamation and encouraged, in the early stages of their history, with more indifference than rice. How rice came into the colony from Carolina in the eighteenth century, how the extension of the crop was deliberately and persistently discouraged because the cereal was being grown as a food crop by run-a-way slaves, how more than a hundred years later there was practically no increase in the area under cultivation, how the production rapidly increased during the Great War and precipitately decreased immediately after, how unfavourable weather conditions very adversely affected the crop as recently as 1918 and 1926, are some of the incidents which adorn the tale of the progress of the industry.

Despite these, the rice industry of British Guiana is probably more firmly established to-day than it has ever been before; the export figures in 1928 were the highest yet recorded, although the prices ruling in 1927 and 1928 were abnormally low—and the outlook for the industry is assuring.

One of the chief parts played by the Department of Agriculture, in the rice cultivation of the Colony, is the growth and the distribution of selected seed of varieties that have been proved to be heavy and uniform yielders of a desirable type of grain, resistant to disease, and having the necessary milling qualities. In 1929, 75,000 lbs. of selected paddy for seed purposes were distributed by the Department. Recently, additional seed stations (one in Essequibo, one on the Corentyne Coast, one in the Canje District, and one in East Demerara) have been established with a view to increasing the supply and facilitating the disposal of seed.

Such development having therefore taken place, and the provision of selected seed having been organised, it became evident that protection of the export trade by grading was the next important step to be taken. The subject received much attention in the local press and in the Chamber of Commerce, which appointed a Committee in June, 1929, to investigate the means of stabilising the industry generally. Little was actually accomplished until the latter part of the year, when there were three important occurrences which were largely responsible for the rapid progress made and for the celerity with which concrete proposals evolved from the deliberations of this Committee. These occurrences were the return of the Director of Agriculture from a trade mission to Canada, where rice marketing problems received special attention; the visit to the Colony of Mr. C. E. Douglas, an expert much experienced in all phases of rice production; the significance attached to the extension of this crop, as a subsidiary industry to cane, by the Sugar Commission under the chairmanship of Lord Olivier.

Early in 1930, a sub-committee, with the Director of Agriculture as Chairman and the Deputy Director as Secretary, was appointed to enquire into, and draw up regulations for, the grading of rice for export. Simultaneously, a collection of samples of all grades, under which the chief exporters shipped, was made and carefully examined by the Department of Agriculture. It was thereby possible to ascertain definitely and accurately the limits between which the mechanical composition (*i.e.*, percentage broken grains, percentage discoloured grains, and percentage whole grains) of each grade varied. Acting on this information, the sub-committee made recommendations as to the grades, with the necessary specifications, into which rice for export should be classified. The final recommendations, submitted by the Chamber of Commerce, received very prompt and vigorous attention from the newly appointed Governor, His Excellency Sir Edward Denham, and were considered at a special meeting of exporters, millers and growers called

by His Excellency. The Legislative Council was then in Session and His Excellency decided that a Bill, based on the findings of the Rice Committee, should be immediately drawn up and efforts made to have the Bill passed before the Council rose.

These endeavours of the Department of Agriculture, in collaboration with the Chamber of Commerce, culminated in the passing by Government of Ordinance No. 18 of 1930 ("to provide for the regulation of the export of rice") followed by the regulations made in pursuance of the said Ordinance. The full text of the ordinance and regulations, with the address of the Director of Agriculture when he introduced the Bill, is published in another part of this Journal.

These regulations come into force as from October 1, 1930. In order that the measure be given full publicity and that the due significance of grading to the industry be realised, the Department of Agriculture has used all means at its disposal for propaganda work. The following have recently been prepared: a leaflet entitled "Parboiled Rice" for the Grocers' Exhibition, London, and for the Nova Scotia Provincial Exhibition; an illustrated brochure entitled "Buy Demerara Rice" for distribution mainly in the Caribbean and an article on "The Rice Industry of British Guiana" for a Canada-West India number of the 'Montreal Star'; arrangements have also been made that all letters leaving the colony should be franked with the slogan "Buy Demerara Rice—Government Graded."

The rice industry of British Guiana at the present time is becoming increasingly important. It is conceived that the grading of the product will have a profound effect on the industry, but whatever advantages result from Government legislation and the Department's efforts, these advantages will be in direct proportion to the efficiency and probity with which the measures are carried out by exporters. From these latter, the Department of Agriculture asks for, and expects to receive, full co-operation in all phases of this new undertaking.

ORIGINAL ARTICLES.

RICE CULTIVATION IN ITALY

BY

F. BURNETT, M.C., M.A. (Oxon.)

Deputy Director of Agriculture.

In accordance with instructions from the Colonial Office, I was privileged to visit the Rice Experimental Station at Vercelli, Italy, in order to study the latest methods employed there for the improvement of rice cultivation generally.

The Rice Experimental Station was founded in 1908 and is financed chiefly by contributions from the cities of the province (IL Vercellose), the Chamber of Commerce, the Farmers' Syndicate and by Government.

The definitions and explanations of measures, etc., given in this article are as follows:—

(1) Hectares — 2.47 acres.
(2) Quintal — 100 Kilos — 220 lbs.
(3) Kilo — 2.2 lbs.
(4) Paddy — Grain before being husked.
(5) Exchange — 93.25 lire to £1 sterling.

The Institution is separate from the Agricultural Department and is devoted entirely to the improvement of rice and experimentation with fish (*carp*). The work is divided into the following sections:—

(1) Agriculture.
(2) Machinery.
(3) Chemistry.
(4) Genetics.
(5) Fish.

There are also thirty hectares (74.1 acres) of paddy land under the control of the Institute for experimental work. The following is a brief resumé of the class of work done under each of the above sections.

1. Research work with new varieties, both in the field and at the experimental station. The selection of seed in mass on the farms, manurial trials and the general study of new methods of rice cultivation.
2. The study of rice agricultural machinery. At the present moment the improvement of the machine for transplanting rice is being worked upon. The officer in charge of this branch is a fully qualified engineer.
3. Research work connected with rice, manures and soils.
4. Hybridization and pure line selections.
5. Experimentation with carp and propaganda work.

The area under rice cultivation in Italy at the present time is approximately 150,000 hectares (370,500 acres) and I was informed that this area will not, to any extent, be increased in the near future, chiefly because of the system of agriculture practised and also that all suitable irrigable land is already under rice cultivation.

It is estimated that 90-95 per cent. of this area is situated in the North of Italy.

The farms can be divided into two distinct classes, (1) large farms of between 200 to 300 hectares (494-741 acres), and (2) small farms of 10 to 15 hectares (24.7-37.05 acres) each. An interesting point about these is that the small farms are generally owned whilst the large farms are generally rented. The rent for paddy land is paid in kind, varying from 10 to 15 quintals (2,200-3,300 lbs.) according to the richness of the land per hectare. All the paddy is grown on irrigable land and there is an ample supply of water.

There are very few varieties grown, compared with other rice-producing countries—estimated to be less than twenty, of which the following are the chief :—

1. Americano 1600 (awnless).
2. Ostiglia (awned).
3. Bertone (awnless).
4. Lencino (awned).
5. Ranghino (,,)
6. Nero Vialone (awnless).
7. Orijinarios (awnless)†.
8. Onsen†
9. Sekyama (awned).
10. Sancius (awnless).
11. Precoce (,,)
12. Precoce Declarole (awnless).
13. Precoce Allorio (,,)
14. Precoce Giallo (,,)
15. Precoce Vittoria (,,)
16. Maratelli.

The chief kind grown is the original Chinese variety (*Originario cinese*) and it is estimated that four-fifths of the whole area is under this variety. The varieties above marked with † sign are also heavy yielders. The age of each, from the time of sowing to maturity, varies from 5 to 5½ months. Only one crop of paddy per year is grown. The yield per hectare for the 1930 crop was estimated, on an average, at 55 to 60 quintals (5-6 tons) equivalent to 100 to 120 bushels per acre.

Every year the Institute imports new varieties from other rice-growing countries, but from Japan and America chiefly. These varieties are sown on the Experimental Station, and if they show signs of conforming to requirements, *i.e.*, heavy yielders, even samples for commercial use, freedom from disease, they are then given out to various large farmers for trial and acclimatization. Some farmers have as many as 15 to 20 varieties in small lots. I was privileged to visit several of these farms, and the variation in growth and the age of ripening was as usual very great. The best varieties are, however, eventually harvested and seed kept for further trial. It takes two or three years before a new variety becomes acclimatised. Varieties even vary in time taken to maturity when exchanged between the North and South of Italy. Where a variety has been found suitable, the area is gradually increased each year. This was the method employed with the variety Americano 1600. The seed was only imported in 1920, and it is estimated that four-fifths of the whole area under rice cultivation is now grown with this variety. Seed in large quantities is not distributed from the experimental station.

There is no dry rice cultivation.

The typical rotation in the region most intensively cultivated with rice (IL Vercellose) is the following :

1st year— Wheat.
2nd „ — Meadow land.
3rd — Meadow land with casual maize and transplanted rice.
4th — Rice.
5th
6th
7th

General cultivation commences in April. The only difference in the general methods of cultivation of rice following wheat and rice following rice is that transplanting is necessary after wheat, instead of broadcasting, to ensure its ripening at the correct time. Every precaution is taken to ensure that the crops are ready for reaping in September, as the harvesting season is short and different from other rice-growing countries where this season is much longer.

Before ploughing the land, farm-yard manure is applied in varying quantities according to the amount available up to 400 quintals (approx. 40 tons) per hectare. The land is then ploughed and on some farms, where the tractor is used, the harrow is also attached to the plough, and both operations carried out at the same time.

Tractors are only used on the large farms. On the smaller farms ploughing is done by means of horses and oxen.

Where farmyard manure has not been applied, artificial manure is applied at the time of sowing at the following rate per hectare.

8 quintals (1,760 lbs.) of superphosphate.
3 „ (660 lbs.) of Potassic manure and if the crop requires it
1 quintal (220 lbs.) of Sulphate of Ammonia after weeding.

One farmer informed me that he used Sulphate of Ammonia only, at the rate of 250 Kilogrammes (550 lbs.) per hectare.

The soil is then harrowed a second time and irrigation commences. After 4—5 days the soil is well mixed by means of a puddling machine drawn by a tractor or horses. Levelling is, however, done entirely by hand implements.

Before sowing commences, either in the nursery or in the field, the seed is selected by a machine. This machine is in use on large farms, is popular and effective. On small farms sowing by hand is still in practice.

It is estimated that 25 per cent. of the total rice area is transplanted. A machine for transplanting is in use, but it is not yet very popular. This undoubtedly is due to the failure of various types of transplanting machines that have been previously placed on the market. The latest machine is claimed by the Institution to be fairly successful. Last season it was estimated that, out of 35,000 hectares (86,450 acres) transplanted, about 5,000 were planted by the above type of machine. The work of transplanting with this machine has to be done slowly, and with very little water in the fields. Horses dragging the machine have to be changed every two hours. It is estimated that one hectare can be transplanted in one day. The plants, whether by machine or by hand, are planted in threes and fives at 8 inches apart. If transplanting is done by hand, it is estimated that it will take 40—45 women one day of 8 hours to transplant one hectare.

The sowing of the seed on the remainder of the area—115,000 hectares (284,050 acres)—is done by machines on the large farms and broadcast on the small farms. This type of sowing machine has been evolved after considerable experimentation, is efficient, and very popular.

The rate of sowing is 150 kilogrammes (330 lbs.) per hectare. Thinning out is done both by machine and hand. Where the seed has been sown by a "drill" or transplanted by a machine, then weeding with a horse-drawn machine is possible. This type of machine is considered most satisfactory. When the crop has been broadcast, then weeding is done by hand.

The harvesting is done entirely by hand by means of a sickle. The water is drawn off the fields about 14—21 days before harvesting commences and clover sown (*Trifolium incarnatum*). Reaping machines are not in use, and attempts made so far have ended in failure. Several types have been tried, both horse and hand motor reaping machines, but they have not been successful.

The crop is then carted to the Homestead and threshed by means of a threshing machine. On large farms the machine is fixed. The small farmer gets his threshed by means of an itinerating threshing machine, *i.e.*, on the same principle as the English small farmer gets his corn threshed.

It is estimated that about 16 quintals (3,520 lbs.) can be threshed in one hour. The grain is then winnowed and dried.

The winnowing machine is called a pulitore, and the drying machine an essiccatoio. Due to uncertain weather for drying the grain, artificial drying is resorted to, although on the small farms it is sun-dried by being placed in the sun on cement and asphalt floors. Unless the paddy is to be husked and polished, it is now ready for sale. Both the large and the small farmers dispose of their crop as paddy, which is generally purchased by the rice millers who prepare it according to the demands of the different markets. The rice in some cases is not polished, owing to a lower export rate for unpolished rice, and it depends on the market price whether or not it is profitable to polish.

Both the paddy in the rough and cleaned rice are sold to private stores. The charge for husking and polishing 100 kilos (220 lbs.) is 7 lire ($0.36) plus the by-products after husking.

The proportion of rice to paddy is 63-65 per cent. and the remainder is made up of 20 per cent. husks, 9 per cent. broken rice and 6 per cent. meal. The husks are used as firing material, the broken rice is generally converted into beer and there is also a market for the meal. These private stores are established in every large rice-producing district in the North of Italy and are entirely privately owned. In Vercelli town there were seven such factories of commerce.

I was informed that there were no co-operative buying or selling institutions in operation as far as rice is concerned.

The crop everywhere is fed entirely throughout by means of irrigation and does not depend on rain water. There is a water rate levied, amounting to between 250 and 300 lires ($12.87-$15.44) per hectare per annum. The consumption of water varies in the following manner :—

Clay soils	... ...	1.5 litres (0.33 gallons) per hectare daily.
Intermediate soils	...	2.5 litres (0.55 gallons) per hectare daily.
Light soils	... ...	5.0 litres (1.10 gallons) per hectare daily.

There is no Malaria in the rice-growing district now, although I was informed that the mosquito is still found. The eradication of fever is thought to be due to better sanitary conditions and also to the growing of crops in rotation in irrigated fields.

It is estimated that 25-30 per cent. of the crop is exported yearly, the chief countries outside Europe being the Argentine and Chile. Rice is eaten in Italy, mixed with vegetables in soup, curried with meat and ground into flour.

In my opinion the flavour of the rice is not as good as that of some of the varieties grown in Ceylon, nevertheless it should be mentioned that Italian rices are regarded with favour on the international market.

The price of manual labour varies from 15 to 20 lire ($0.77 to $1.02) per day according to the grade of workman and time of the year. During the harvesting period, 20 lire ($1.02) a day is paid. Women are paid a little less, but, during harvest, 18 lire ($0.95) a day is paid.

As far as I could ascertain no assistance or support is given to the farmers from Government excepting through and by this Institution. Money, however, can be borrowed from Agricultural Banks at the rate of 6½ per cent. on security of the crop after inspection.

There are no pests of importance. A recently imported variety of paddy had, however, met with misfortune and had completely died out. The crop had grown and eared well, but just before ripening it entirely failed. This is one of the difficulties of acclimatization, in spite of the success of this variety the previous year.

The study of Economics of rice cultivation has not yet been attempted at the Institute. The labour question, however, is not, I understand, a difficult one, and during the busy times of the year the farmers co-operate and help each other.

In "IL Giornale de Risicoltura" for June, 1929, full details are given of the methods of hybridization employed at the Institution. By this method 95 to 97 per cent. successes are obtained.

The names and addresses of firms supplying the rice machinery now used on the farms are as follows :—

Agricultural Machinery	...	Cabbrini & Mocchi, Pavia.
Husking and Polishing machines	...	Morandi and Minghetti, Vercelli, Italy.
		P. Cattananeo & Figli, Pavia, Italy,
Threshing machines	...	Brusa Vittore, Vercelli.
		Sacerdate, Coutoni & Co., Vercelli.

I was able to obtain a wide range of photographs dealing with rice cultivation in its various stages, but, as space will not permit publication, I shall be happy to loan them to anyone interested.

AN AGRICULTURAL SURVEY OF THE WARANAMA SAVANNAH, BERBICE RIVER.

INTRODUCTORY NOTE

BY

PROFESSOR J. S. DASH, B.S.A.,

Director of Agriculture.

The indications are that of the occupations pursued by the agricultural community in British Guiana, there is none which at the present time offers more promise and more encouragement for development than stock, particularly cattle, raising. It is therefore conceived that the following agricultural survey of a ranch (situated on the Berbice River, but intimately connected with the Rupununi District, the most important ranching district in the colony) is deserving of more than cursory perusal. It is thought, further, that a clear conception of the system of marketing animals, raised in the Rupununi, will aid considerably in the realisation of the full significance of this survey.

The Rupununi cattle trail starts at Annai, which is 180 miles from Takama where the trail ends and the cattle are put on board ship, Takama being situated on the Berbice River. Over this tract of 180 miles, the cattle are driven in herds, the journey taking normally 10 days. There are corrals dispersed, near to watering places, at convenient distances along the trail where stoppages are made at the end of each day's 'trek.' Watering facilities are quite suitable throughout the journey and grazing can be obtained for about 67 miles from Annai ; from this point, however, for about 73 miles, the soil in the area adjacent to the trail is of a deep infertile sand type (muri) which only supports sparse xerophytic vegetation of little value for fodder. It is clear, therefore, that the condition of the cattle at the end of the journey is very different to that at the beginning. Hence, it is apparent how essential it is that ranches be situated at or near Takama (Waranama is only 10 miles from Takama) where the animals may be kept and re-conditioned, and it is also apparent what significance these re-conditioning ranches bear to the whole Rupununi cattle industry.

Unless there are other means of transport, e.g., by rail, of animals from the Rupununi or until suitable pasturage can be established at the different halting places, especially in the "muri" sand area, there is little likelihood that these re-conditioning ranches will be less indispensable than they are at present. In this connection, it may be mentioned that the Department of Agriculture has

obtained, and supplied to the ranches in the Rupununi, planting material of various fodder crops for trial in the area.

This joint survey by the Government Veterinary Surgeon, the Chemist-Ecologist and the Botanist,* is the first of a series which it is contemplated will be made in the chief cattle raising districts. The data collected and the conclusions drawn indicate how important it is that these surveys should be continued and how invaluable can be the information presented to the local ranching community.

*The report of the Botanist will be published at a future date.

THE REPORT OF AN INVESTIGATION OF THE SOILS AND OF THE MINERAL CONTENT OF PASTURE GRASSES OCCURRING AT WARANAMA RANCH, BERBICE RIVER.

BY

R. R. FOLLETT-SMITH, B.Sc. (Lond.), A.R.C.S.
Chemist-Ecologist, British Guiana.

CONTENTS :—

1. *INTRODUCTION.*

A visit has been paid to the cattle ranch of the Rupununi Development Company and a number of soil samples and collections of the principal pasture grasses have been obtained. The ranch at Waranama is used as a rest camp for cattle on their journey from the savannahs of the Rupununi to the coast. It has been noted that animals remaining upon the ranch for any length of time become emaciated. A few of the animals develop a pica for bones. It was suspected that the grasses of the ranch were deficient in minerals and in consequence the samples of pasture grasses obtained were examined in respect of their mineral matter content. The observations made, the results of the laboratory examination of the samples collected, and the deductions drawn therefrom are described.

The principal objects of the survey were :—

(1) The inspection of the chief soil types occurring upon the ranch.

(2) The collection of samples of the principal pasture grasses occurring upon the ranch.

(3) The laboratory examination of the samples obtained.

(4) The suggestion of possible means for the improvement of the pasturage of the ranch.

2. *TOPOGRAPHY OF THE AREA.*

The Waranama ranch is situated some ten miles to the west of the Berbice River. It is bounded on the north by the Wiruni Creek and on the

Photo by *R R Follett-Smith.*

FIG. I—MURI SAND.

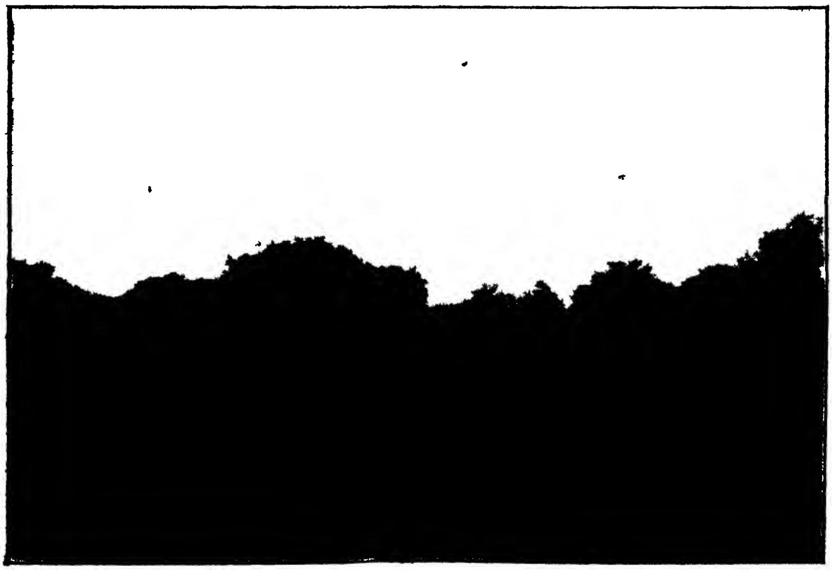

Photo by *C. L. Wardlaw*

FIG. II—TYPICAL SAVANNAH COUNTRY.

south by the Ituni Creek. The ranch is some seventy-eight square miles in area and is approximately 80 to 90 feet above sea level. Its approximate geographical position is latitude 5° 34'N and longitude 58°W. The sketch map attached indicates the position of the ranch and the general direction of the excursions undertaken. The country is, for the most part, an undulating savannah supporting a thin xerophytic vegetation, consisting principally of grasses and sedges, which covers roughly some 60 per cent of the surface of the soil. There are scattered areas of forest, occurring mainly in the vicinity of creeks and streams. A feature of the appearance of the open savannahs is the number of mounds raised by ants; this subsoil, brought up by their activities, supports a flora apparently capable of withstanding the periodic savannah fires and resembles that found in the narrow transition zone between forest and open savannah country. Other variations are the presence of water holes, water-logged in the wet season but dry during periods of drought, and the occurrence of slightly elevated and isolated areas of coarse white sand locally known as 'muri' sand.

Meteorological data for the area under consideration are unfortunately unavailable. Table I gives the distribution of the mean annual rainfall recorded at Ida Sabaina some eleven miles distant from Waranama. Ida Sabaina is situated in the valley of the Berbice River, and it is probably subjected to a higher raintall than the neighbouring savannahs. The area was surveyed and the grasses were sampled during the period August 29, 1929, and September 4, 1929, at the commencement of the dry season.

TABLE I.

RAINFALL IN INCHES AT IDA SABAINA.

Months	1924	1925	1926	1927	1928	1929	Mean
January	1.54	1.92	nil	8.96	8.12	1.69	3.70
February	0.81	3.48	nil	7.22	5.25	3.39	3.36
March	0.87	5.33	nil	2.26	3.10	4.72	2.71
April	1.93	3.61	2.06	2.97	12.92	8.12	5.27
May	6.65	6.47	15.13	14.01	14.43	14.54	11.87
June	14.85	5.46	15.94	14.22	15.42	16.16	13.67
July	17.32	10.38	9.95	11.14	7.37	10.54	11.12
August	6.03	15.38	8.67	5.98	10.80	7.17	9.00
September	5.32	0.44	6.52	6.99	2.21	3.76	4.21
October	0.75	2.44	3.38	9.35	2.24	2.36	3.42
November	2.87	2.65	9.13	2.11	3.08	8.17	4.67
December	7.30	2.35	10.73	12.68	6.09	6.68	7.64
Total	66.24	59.91	81.51	97.89	91.03	87.30	80.65

3. *DESCRIPTION OF SOIL TYPES.*

A general inspection of the area carried out during the excursions disclosed the existence of three main soil types. It was impossible, in the limited time available, to attempt the preparation of a map depicting the distribution of these soil types. They were, however, examined in profile, and they may be described as follows :—

(a) *Brown Sand Type.*—This type of soil appeared to be the most widely spread upon the area surveyed. Seen in the field it is an orange brown sand, at some points very loose and incoherent, at others very tightly packed. The type consists of a topsoil of fine sand, ten inches deep and brown in colour, the immediate subsoil is slightly lighter in colour and merges at a depth of two feet from the surface into a slightly heavier red brown loam. This soil was examined to a depth of four feet, and showed little variation in texture or colour. The appearance of this profile is shown in Diagram I*a**, while the results of the laboratory examination of the samples obtained are given in Table II.

TABLE II.

Brown Sand Profile.

Sample No.		D 88	D 89	D 90	D 91
Depth		0-10″	10-20″	20″-34″	34″-48″
Normal reaction pH		4.87	5.13	4.83	4.85
Exchange reaction pH		4.47	4.57	4.35	4.50
Loss on ignition	% Oven Dry Soil	3.91	4.01	4.51	4.31
Combined water	ditto	3.31	3.85	4.32	4.22
Silica	ditto	86.23	82.74	79.95	80.44
Alumina	ditto	6.64	9.80	11.10	10.69
Ferric oxide	ditto	2.18	1.95	2.69	2.41
Titanium oxide	ditto	1.42	1.51	1.86	1.66
Calcium and Magnesium oxides	ditto	nil	nil	Trace	Trace
Moisture at point of stickiness	ditto	23.0	23.4	25.6	23.6
Sand (1.0-0.4 mm)	% Air Dry Soil	82.3	75.5	68.3	69.2
Organic matter	ditto	0.60	0.16	0.19	0.09
Lime reqt.	ditto	0.10	0.09	0.09	0.09
Index of Texture		7	8	12	10
$\frac{\text{Silica}}{\text{Sesquioxide}}$ – Mol. Ratio		18.20	12.68	10.50	11.03
$\frac{\text{Alumina}}{\text{Ferric oxide}}$ Mol. Ratio		4.83	7.89	6.44	6.96
Colour		Brown	Pink brown	Pink brown	Pink brown

* The Diagrams are not here reproduced.

Inspection of the results appended in Table II shows that the topsoil of the profile consists of a sand to the depth of twenty inches overlying a light loam. There is little variation in the normal or exchange reactions throughout the profile. The soil obtained between the depths of ten and twenty inches is slightly less acidic, but all samples may be classed as markedly acidic. The organic matter content of the topsoil is low and it decreases to a negligible quantity at a depth of ten inches. The amount of combined water increases slightly with depth, and this gradient coincides with an increase in the aluminium oxide *plus* ferric oxide content. There is a slight decrease in the silica content in the depth, and this coincides with a decrease in the amount of coarse and fine sand. The molecular ratio of aluminium oxide to ferric oxide is lowest in the first horizon, greatest in the second horizon and of an intermediate value in the two lower horizons. The molecular ratio of silica to sesquioxide decreases from above downwards to a depth of thirty-four inches ; the fourth horizon shows an increase in this value. There appears to be a slight accumulation of titanium oxide in the third horizon. Calcium and magnesium are absent from the first two horizons of the profile and present as traces in the two lower horizons.

The lime requirements of the soils are low and show little variation throughout the profile. Only one outcrop, consisting of boulders of ferruginous sandstone was found upon the soil of this type.

(*b*) *The sand hill type.*—This soil type is of less common occurrence on the area surveyed. It is to be found in the vicinity of Waranama Creek. In colour it varies from light to dark grey and contains slightly more organic matter than the soil of the brown sand type. Examination of this soil to a depth of twelve feet showed that the profile, in appearance, was identical with those obtained on the sand hill area of the North West District.[1] The appearance of this soil profile is shown in Diagram I b.,* while the results of laboratory examination of the samples obtained are given in Table III.

TABLE III.

Sand Hill Profile.

Sample No.	D 47	D 48	D 49	D 50	D 51
Depth	4"-17½"	17½"-37"	37"-61"	61"-122"	122"-139½"
Normal reaction pH	4.65	4.35	4.07	4.53	4.00
Exchange reaction pH	4.22	4.30	4.10	4.45	4.22
Loss on ignition % Oven Dry Soil	3.5	4.5	7.4	7.7	6.1
Combined water ditto	2.7	4.2	7.0	7.6	6.1

[1]FOLLETT-SMITH, R. R. Rept. Soil Survey of an area of the North West District of British Guiana, Chem. Bull. No. 1. Dept. of Agr. Br. Guiana.

*Not here reproduced.

TABLE III. (*Continued.*)

Sand Hill Profile. (*Continued.*)

No. Sample		D 47	D 48	D 49	D 50	D 51
Depth		4"-17½"	17"½"-37	37"-61"	61"-122"	122"-139½"
Silica	% Oven Dry Soil	89.5	82.5	70.6	68.3	76.1
Alumina	ditto	5.11	9.83	17.75	20.21	5.78
Ferric oxide	ditto	1.34	1.99	3.01	3.35	2.08
Titanium oxide	ditto	0.75	1.20	1.50	1,78	1.35
Calcium and Magnesium oxides	ditto	nil	nil	nil	nil	nil
Moisture at point of stickiness	ditto	18.5	20.3	29.0	34.0	24.0
Sand (1.0-0.4 mm.)	% Air Dry Soil	84.2	72.2	65.7	71.0	84.0
Organic matter	ditto	0.79	0.33	0.41	0.14	0.03
Lime Reqt.	ditto	0.14	0.11	0.18	0.12	0.10
Index of Texture		2	6	16	20	7
$\frac{\text{Silica}}{\text{Sesquioxide}}$	Mol. Ratio	25.2	12.5	6.0	5.1	18.0
$\frac{\text{Alumina}}{\text{Ferric oxide}}$	Mol. Ratio	5.97	7.74	9.25	9,45	4.36
Colour		Grey	Yellow	Yellow & Pink	Pink & Yellow	Pink

The samples were obtained from an abandoned well, and the first four inches, composed of subsoil thrown up during the construction of the shaft, were discarded. There appears to be a marked change in the composition of the soil at a depth of ten feet, and it is possible that the parent material was reached at this depth. All the soils are highly acid and there is little variation in the normal and exchange reactions with increasing depth. A point of interest is the small differences obtaining between the normal and exchange reactions, and that the exchange reaction of the fifth horizon is less acid than the normal reaction, as measured by the quinhydrone electrode. There is a marked increase in the loss on ignition from above downwards to a depth of ten feet, a slight drop in this figure occurs at the fifth horizon. The organic matter of the first horizon is low and it decreases with depth, the amount below the first horizon is negligible. The amount of combined water increases with depth as far as the fourth horizon, and this gradient coincides with an increase in the aluminium oxide plus ferric oxide content. The molecular ratio of aluminium oxide to ferric oxide increases markedly to a depth of ten feet; a notable drop in this ratio occurs in the fifth horizon. There is a slight but definite decrease in silica content from the first horizon to the fourth horizon, and a sharp rise in this figure for the fifth hori-

zon. The molecular ratio of silica to sesquioxides decreases from the first to the fourth horizon, a marked increase is noted in the fifth horizon.

There is a definite increase in titanium oxide content with increasing depth to the fourth horizon, the fifth horizon contains slightly less of this constituent. Calcium and magnesium are present in very small amounts. There is a definite increase in textural heaviness to a depth of ten feet. The first and second horizons are sands, the third and fourth horizons are light loams while the fifth horizon is a sand. The lime requirements of the soils are low and vary but little throughout the profile.

The main differences in the soils of this profile from those obtained in the North West District are in the titanium oxide contents and in the index of texture[1] of the lower horizons. The soils of the Waranama profile contain more titanium oxide and the lower horizons are lighter in texture than are the corresponding ones from the North West District.

There is an outcrop of soft, white, red-streaked rock at the Waranama spring situated some three hundred yards distant, and one hundred feet below the position of the spot where the profile was examined. The analysis of the clay fraction separated from the powdered sample gave a molecular ratio of silica to alumina of 1.96.

(c) *The Muri Sand Type.*— The muri sands are an inextensive type in the area surveyed. They occur upon slight elevations and are usually accompanied by the presence of a water-hole. They consist of coarse white rounded grains of quartz, and they merge gradually into the brown sand type. The muri sand supports a typical plant community, the constituents of which are of a markedly xerophytic nature.

A profile of this soil type was examined to a depth of five feet and its appearance may be seen upon reference to diagram I c.* The results of the analytical examination of the samples of soil taken from this profile are presented in Table IV.

TABLE IV.

Muri Sand Profile.

Sample No.		D 53	D 54	D 55	D 56
Depth		0-9″	9″-23″	23″-42½″	42½″-63½″
Normal reaction pH		4.68	5.47	5.33	5.78
Exchange reaction pH		4.53	4.62	5.12	5.50
Loss on iginition	% Oven Dry Soil	0.50	0.20	0.10	0.00

[1] HARDY. F. J., Agr. Sci. XVIII, p. 252, 1928.

* Not reproduced.

TABLE IV.—(*Continued.*)

Muri Sand Profile.—(*Continued.*)

Sample No.		D 53	D 54	D 55	D 56
Depth		0-9"	9-"23"	23"-42½"	42½"-63½"
Silica	% Oven Dry Soil	99.56	99.90	99.95	99.85
Alumina plus Ferric Oxide	ditto	0.16	0.10	0.10	0.10
Calcium and Magnesium oxides	ditto	nil	nil	nil	nil
Moisture at point of stickiness	ditto	indeterminable	indeterminable	indeterminable	indeterminable
Sand (1.0-0.4 mm.)	% Air Dry Soil	91.0	88.0	82.0	84.7
Organic matter	ditto	0.19	0.07	nil	0.01
Lime reqt.	ditto	0.05	0.04	0.02	0.01
Index of Texture		0	0	0	0
Colour		Light grey	White	White	White

There is a slight increase in the normal and in the exchange reactions with depth. The figures for the loss on ignition are very small, and decrease with increasing depth. The organic matter content of all horizons is small, but there is a slight accumulation in the topsoil which renders the first horizon very light grey in colour. The silica content does not vary throughout the profile. The contents of aluminium oxide and ferric oxide are negligible. Calcium and magnesium are absent from the soils of the profile. The content of titanium oxide was not determined, but microscopical examination of the soils failed to reveal the presence of ilmenite. The lime requirements of the horizons are very small, and decrease with increasing depth. The percentage of coarse and fine sand (greater than .04 mm. diameter) decreases from above downwards.

Consideration of the above descriptions and of the results presented in Tables II, III and IV shows that the principal soil types occurring upon the Waranama ranch are highly leached siliceous sands, acid in reaction and of low organic matter content. It is probable that such soils are deficient in plant nutrients. Consideration is given to this point in section six, where the results of further laboratory examination of typical samples of the principal soil types are reported.

4. *DESCRIPTION OF SAMPLES OF PASTURE GRASSES COLLECTED.*

Duplicate samples of the principal, naturally occurring grasses were collected together with samples of two introduced grasses (Bahama grass and Para grass). Samples of pasture grasses growing upon the coastal alluvial clay at the Government Stock Farm, Georgetown, have also been examined and serve as a standard of comparison for the savannah grasses.

A description of the samples of pasture grasses collected is appended.

(1) *Axonopus attenuatus* Hitchc.—This grass is a constituent of the flora of the muri sands. It also occurs at the edges of the water-holes. It appears to be cropped by cattle, but it is of limited occurrence.

(2) *Trachypogon plumosus* Nees.—This grass is the most widely occurring species forming usually about one-quarter of the grass-sedge association. It is one of the savannah grasses observed to be cropped by the cattle.

(3) *Trachypogon plumosus* Nees.—(From a burnt area). During the dry season the clumps of grass consist of a mass of dead and dry material with a few green leaves. The cattle will not graze on the grass in this condition, and it has been the custom to burn areas of the savannah. The young, freshly springing vegetation is apparently more palatable. This sample was obtained from an area which had been burnt one month previously.

(4) *Capriola dactylon* Kuntze.—(Bahama Grass.) An introduced grass planted upon an area which had been limed at the rate of one ton of lime per acre. The grass had been cropped continuously by working horses. It is probable that without some attention this grass would become subdominant to other grasses or to sedges.

(5) *Panicum barbinode* Trin. Mem. Ac.—(Para Grass.) An introduced grass, planted upon an area of savannah soil limed at the rate of one ton of lime per acre. The grass, when sampled, was two months old.

(6) *Axonopus aureus* Beauv.—A natural grass of the savannahs which is of less extensive occurrence than T. plumosus. It was observed to be cropped by cattle.

(7) "*Pan Grass.*"—A mixed samples of the grasses occurring in the water holes.

In addition to these sample of savannah grasses a number of collections were made at the Government Stock Farm, Georgetown.

(8) *Pasture Grass of Government Stock Farm.*—A mixed sample of pasture grasses growing on the Government Stock Farm, Georgetown. An inspection of this pasturage indicated that the principal constituents were :—

Gramineae.	Paspalum conjugatum Berg.	(Sour grass)
	Panicum laxum Sw.	(Bird Seed grass)
	Sporobolus indicus R. Br. Prod.	(Iron Grass)
	Paspalum virgatum L.	(Razor Grass).

Leguminoseae. Alysicarpus varginalis DC. (Horse Weed.)

Commelinaceae. Commelina nudiflora L. (Zeb Grass.)

(9) *Capriola dactylon* Kuntze.—(Bahama Grass.) A sample, two months old, collected from the Government Stock Farm.

(10) *Panicum barbinode* Trin. Mem. Ac.—(Para Grass.) A sample, two months old, collected from the Government Stock Farm.

(11) *Pennisetum purpareum* Schum.—(Elephant Grass.) A sample, two months old, collected from the Experiment Station, Georgetown.

(12) *Commelina nudiflora* L. (Zeb Grass.) A sample, two months old, collected from the Government Stock Farm.

(13) *Asystasia scandens* Hook.—(Demerara Primrose.) A sample collected from the Botanic Gardens. A description by the Government Veterinary Surgeon of this fodder crop has appeared in a recent number of the Agricultural Journal.

(14) *Uba Cane.*—A sample of Uba cane stalks.

5. *LABORATORY EXAMINATION OF PASTURE GRASS SAMPLES.*

The duplicate samples of pasture grasses collected were separately examined as to their content of :—

(a) Total ash (carbonate ash)

(b) Silica-free ash

(c) Chlorine

(d) Ferric oxide

(e) Phosphate

(f) Calcium oxide

(g) Magnesium oxide

(h) Potassium oxide

(i) Nitrogen.

The means of determinations upon duplicate samples of the savannah grasses are presented in Table V. Single samples of the grasses of the Government Stock Farm were examined. The table also presents the results of analysis of grasses ocurring in other parts of the world.[1]

1. ORR, J. B., 'Minerals in Pastures,' p. 13.

TABLE V.

Analysis of Pasture Grasses on Oven Dry Basis.

	Total ash	Silica-free ash	Chlorine	Ferric Oxide	Phosphate	Calcium Oxide	Magnesium Oxide	Potassium Oxide	Nitrogen.	Iron % Ash.
			SAVANNAH GRASSES.							
A. attenuatus	4.12	1.08	0.06	0.05	0.01	0.17	0.34	0.34	0.50	0.85
T. plumosus	6.37	0.83	0.03	0.05	0.02	0.12	0.12	0.29	0.48	0.55
T. plumosus (recently burnt)	8.21	1.25	0.03	0.06	0.04	0.12	0.10	0.23	0.74	0.51
C. dactylon	12.82	3.16	0.12	0.12	0.14	0.32	0.26	0.87	1.09	0.65
P. barbinode	10.35	4.90	0.18	0.14	0.15	0.25	0.38	3.01	1.31	0.95
A. aureus	10.13	2.31	0.06	0.07	0.10	0.20	0.62	0.64	0.47	0.48
Pan grass	8.26	2.58	0.07	0.06	0.09	0.21	0.39	0.39	0.55	0.51
			GOVERNMENT STOCK FARM.							
Mixed pasture	10.55	4.75	0.56	0.17	0.92	0.30	0.85	1.61	1.38	1.13
C. dactylon.	8.46	4.12	0.20	0.11	0.22	0.49	0.45	1.38	1.18	0.91
P. barbinode	9.60	5.88	1.56	0.12	0.22	0.25	0.61	2.22	1.21	0.87
P. purpareum Schum.	12.49	8.18	0.47	0.30	0.03	0.28	0.59	3.85	0.85	1.68
C. nudiflora	13.45	8.67	1.92	0.32	0.28	0.93	2.23	3.34	1.80	1.66
A. scandens	15.89	15.09	3.63	0.08	0.82	0.82	2.34	4.54	3.83	0.35
Uba Cane	2.74	1.82	0.12	0.09	Trace	0.07	0.25	0.86	0.09	2.30
			OVERSEAS GRASSES.							
Natural pasture (all grazed)	...	5.85	0.64	...	0.67	0.65	...	2.66	2.50	...
Falkland Islands	...	4.56	0.74	...	0.54	0.29	...	2.20	1.95	...

6. *LABORATORY EXAMINATION OF SOIL SAMPLES.*

A number of soil samples,[1] typical of the area surveyed, were submitted to more detailed laboratory examination. Information as to the content of available potash and phosphate was obtained by extracting the soils with a 1% solution of citric acid while figures for the potential supply of these plant nutrients were obtained by extracting the soil with 10% HCl at 100°C for three hours. The results obtained are shown in Table VI, and a short description of the individual samples is appended:—

D 53 Topsoil O – 9″ Muri sand type. Coarse white quartz sand having a greyish tinge due to the presence of organic matter.

D 54 Subsoil of D 53, 9″ – 23″. Muri sand type. White quartz sand with less organic matter.

D 74 Topsoil O – 12″. Black sand, from a water hole one quarter of a mile north of the compound at Waranama.

D 75 Subsoil 12″ – 18″. The subsoil of the previous sample. A stiff yellow loam.

D 78 Topsoil O – 12″. Black sand with a large amount of organic matter, from a water hole one-quarter of a mile east of the compound at Waranama.

D 79 Subsoil 12″ – 24″. The subsoil of the previous sample. A grey sandy loam containing less organic matter.

DCP XIV A composite sample of the topsoil (O – 12″) of the brown sand soil type.

DCP XV A composite sample of the topsoil (O – 12″) of the sand hill soil type.

DCP XVI A composite sample of the subsoil (12″ – 24″) corresponding to sample DCP XIV.

DCP XVII A composite sample of the subsoil (12″ – 24″) corresponding to sample DCP XV.

D 125 Topsoil O – 8″. Grey clay from Botanic Gardens, Georgetown. Soil supporting *A. scandens.*

D 126 Topsoil O – 8″. Grey clay. Taken in the vicinity of sample spot D 125.

DCP III Topsoil O – 12″. Composite sample of soil from Sophia Experiment Station, situated about a quarter of a mile from Government Stock Farm.

DCP VII Subsoil 12″ – 24″. Composite sample of subsoil from Sophia Experiment Station.

1. The field notes and the results of texture and reaction examinations of all samples obtained are filed at the Head Office, Department of Agriculture, Georgetown.

TABLE VI.

ANALYSIS OF SOIL SAMPLES.

	SAVANNAH SOILS										COASTAL SOILS.			
Sample No.	D 53	D 54	D 74	D 75	D 78	D 79	DCP XIV	DCP XV	DCP XVI	DCP XVII	D 125	D 126	DCP III	DCP VII
Normal reaction pH	4.68	5.47	4.97	4.75	4.93	4.73	4.92	5.00	5.05	5.07	5.60	5.42	5.22	6.93
Exchange reaction pH	4.53	4.62	4.23	4.23	4.38	4.25	4.37	4.23	4.53	4.37	4.43	4.35	4.13	5.75
Moisture at point of stickiness	0	0	28.0	25.0	55.7	25.6	22.9	20.8	24.2	21.1	53.2	51.7	45.3	51.9
Sand (1.0-0.4 mm) %	91.0	88.0	63.8	54.3	51.0	58.7	75.1	84.3	75.3	75.5	13.8	13.4	7.0	10.5
Index of Texture	0	0	15	14	46	14	8	4	9	6	50	49	44	50
Organic Matter %	0.19	0.07	2.66	0.55	7.17	1.55	0.76	0.93	0.21	0.45	1.67	1.67	1.62	0.58
Lime reqt. %	0.05	0.04	0.41	0.21	1.25	0.47	0.11	0.14	0.09	0.11	0.26	0.33	0.40	0.15
Phosphate†	0.003	0.002	0.010	0.003	0.026	0.007	0.0009	0.001	0.001	0.001	0.025	0.018	0.006	0.031
Available phosphate*	trace	trace	0.0017	0.0006	0.0090	trace	0.0005	0.0004	0.0003	0.0003	0.0015	0.0030	0.0015	0.0017
Potash†	0.008	0.006	0.012	0.019	0.012	0.015	0.019	0.012	0.015	0.023	0.121	0.135	0.127	0.123
Available potash*	0.0024	0.0005	0.0034	0.0015	0.0029	0.0024	0.0019	0.0019	0.0024	0.0024	0.0071	0.0123	0.0090	0.0058

* Soluble in 1% citric acid

† " " 10% HCl.

7. *DICUSSION OF RESULTS.*

(*a*) *Pasture grass analyses.*—Inspection of the results of analysis of the samples of pasture grasses collected shows that, in general, the savannah grasses are very markedly deficient in mineral content. While the grasses of the Government Stock Farm are richer in mineral matter than the former grasses, yet they are poorer in the principal constituents than are the natural "all grazed" pastures of Britain. A notable exception to this general statement is *A. scandens* (Demerara Primrose). One fact worthy of notice is the relatively high silica content of the savannah grasses.

(i) *Silica-free ash content.*—The silica-free ash content is a figure by which the feeding value of the pasturage may be roughly judged, since it represents the total quantity of metabolisable minerals present. The pasture grasses of the savannahs, with the exception of one of the introduced grasses (*P. barbinode*) growing upon a limed area, have a lower content of silica-free ash than those of the Falkland Islands, an area where the high mortality among sheep led to an investigation of the mineral content of the pasturage. It will be noticed that the silica-free ash content of *C. dactylon* and *P. barbinode* growing upon the limed savannah soils is markedly higher than that of the natural savannah grasses. Figures for corresponding samples of these grasses, supported by coastal alluvial clay are, however, higher than those obtained from the limed savannah soils. Comparison of the results for the two samples of *T. plumosus* indicates the slight advantage to be derived by burning the savannah grass.

Four of the grasses (*P. barbinode*, *P. purpareum*, *C. nudiflora* and *A. scandens*) growing at the Government Stock Farm compare favourably in respect to their silica-free ash content with the English "all eaten" pastures examined by Godden.[1]

(ii) *Chlorine content.*—The chlorine content of the natural savannah grasses is very low. The imported grasses appear to contain slightly more of this constituent, but compare unfavourably with good English pasturage. Apparently the practice of burning the savannah grass *T. plumosus* has little effect upon its chlorine content.

The grasses of the Government Stock Farm vary considerably in respect to this constituent. The sample of mixed grasses shows an average figure, the sample of Bahama grass possesses a low chlorine content while the samples of Para grass, Zeb grass and Demerara Primrose show a marked accumulation of chlorine. The coastal belt sample of Bahama grass contains slightly more chlorine than that grown on the savannahs. In the case of Para grass the difference is markedly greater.

(iii) *Ferric oxide content.*—Aston[2] has shown that clover, from iron deficient areas in New Zealand, contains less than 0.23% Fe in the ash. The

[1] GODDEN, W. J., Agri. Sci., XVI, 81.

[2] ORR, J. B., Quoted by, "Minerals in Pastures," p. 24.

figures given for the content of ferric oxide show that none of the samples of British Guiana grasses examined are deficient in this constituent. The results are stated both as a percentage of Fe_2O_3 on the oven-dry matter and as a percentage of iron on the total ash.

(iv) *Phosphate content.*—In view of the fact that a few of the cattle grazing upon the Waranama ranch were observed to have a pica for bones, the results of the examination of the pasture grasses, as regards their content of phosphate, are of interest. It wil be seen from Table V that natural English "all grazed" pasture contains 0.67% P_2O_5 on dry matter. The pasture grasses of the savannah are very markedly deficient in phosphate, their content varying from 0.01 to 0.15% P_2O_5 on oven-dry weight. The samples examined were collected at the end of the wet season. It is probable that the phosphate content of the savannah grasses during the dry season is even lower than that here reported.

Of the samples collected at the Government Stock Farm, the mixed pasture and *A. scandens* contain adequate supplies of this constituent while the other grasses examined are phosphate deficient, Elephant grass having a markedly low phosphate content. It will be seen that the burning of the naturally occurring savannah grass, *T. plumosus*, has brought about an inconsiderable increase in the phosphate content.

(v) *Calcium oxide content.*—Taking the figure of 0.65% CaO in dry matter as an average value for a nutritive pasture, it is seen that all samples both from the coastlands and from the savannahs, with the exception of *A. scandens* and *C. nudiflora*, are deficient in calcium oxide. It should be noted that, of the savannah grasses, which are all markedly deficient in this constituent, the sample of *C. dactylon*, growing on a recently limed area, contains the highest percentage of calcium oxide. The coastland sample of this grass is richer in this constituent than is that from the savannahs. No such difference is to be noted in the case of *P. barbinode*. It appears that the practice of burning the natural savannah grass has little effect upon the calcium content of the pasture grass, *T. plumosus*.

(vi) *Magnesium oxide content.*—The magnesium oxide content of the savannah grasses, with the exception of *A. aureus*, is relatively low. Most of the grasses growing upon the coastal alluvial belt contain normal amounts of this constituent, the two grasses *C. nudiflora* and *A. scandens*, however, contain large amounts of magnesium oxide. It is probable that the amount of magnesium oxide, present in the grasses examined, is sufficient for the requirements of grazing animals.

(vii) *Potassium oxide content.*—The potash content of the naturally occurring savannah grasses is low. There is a marked accumulation of this element in the introduced grass, *P. barbinode*. Of the pasture grasses growing upon the coastal alluvial belt, *P. purpareum*, *C. nudiflora* and *A. scandens*, show a slight accumulation of potash. The practice of burning the savannah grass appears to have a slight depressing effect upon the amount of potash present.

(viii) *Nitrogen content.*—With the exception of the sample of Demerara Primrose, which contains a high percentage (3.83%) of nitrogen, the samples of British Guiana grasses studied are deficient in this constituent. Of the savannah grasses it will be seen that the two introduced species, Bahama grass and Para grass, growing upon limed soil, contained the highest percentage of nitrogen. It will be noted that the young grass, springing on burnt areas of the savannah, contains a higher proportion of nitrogen than does the older grass occurring on the unburnt areas.

It will be observed that the results reported for Uba Cane are low in every respect. These figures, referring to the analysis of stems, naturally cannot be compared with those relating to the leaves of fodder crops.

In general, the examination of the samples of the savannah grasses, indicates that they are deficient in every ash constituent estimated, with the exception of iron and, possibly, magnesium.

The grasses collected from the vicinity of the Government Stock Farm are, in general, deficient in phosphate, calcium and nitrogen. Compared with the natural "all grazed" pastures of England, the Demerara Primrose contains a higher proportion of all the ash constituents measured.

(b) *Soil Analyses.*—The results of the laboratory examination of soil samples typical of the Waranama savannah and of the coastal alluvial belt are given in Table VI.

Composite samples (DCP XIV, XV, XVI, XVII) of the widely occurring brown sand type and the sand hill type are markedly acid sands of low organic matter content. They possess a low lime requirement (2.5-3.0 tons ground limestone per acre). These soils are markedly deficient in both available and potentially available phosphate. Their content of available and potentially available potash is low. They are the products of a leaching action, which, in the absence of a protecting forest covering, is intense.

The samples of the muri sand type (D 53, 54) are markedly acid light sands of low organic matter content. They possess a low lime requirement (1 ton per acre), and are markedly deficient in both available and potentially available phosphate and potash.

The top soil samples, collected from the water holes of the savannahs, are markedly acid. They vary in texture from light loam to clay. They contain large amounts of organic matter and possess lime requirements varying from nine tons to twenty-eight tons to the acre. They are deficient in available and potentially available potash. Their content of potentially available phosphate is low. The available phosphate content of sample D 74 is low, while that of sample D 78 is high. The corresponding subsoils are markedly acid light loams of varying organic matter content. They possess lime requirements varying from five to ten and a half tons of ground limestone per acre.

Photo by *C. L. Wardlaw*

FIG. III—RANCH BUILDINGS AT WARANAMA.

Photo by *R. R. Follett-Smith.*

FIG. IV—WARANAMA RANCH—ANIMAL CHEWING BONES.

Their contents of potash and phosphate, both available and potentially available, are low. It has been noted that the two introduced grasses, Bahama and Para grasses, growing upon limed savannah soil, possess a higher content of every constituent measured, with the exception of magnesium oxide, than do the naturally occurring savannah grasses. It is impossible to say whether this superiority is due to the application of lime or to the inherent properties of the two varieties.

Samples, typical of the topsoil of the coastal alluvial clays in the vicinity of the Botanic Gardens (D 125, 126, DCP III), are markedly acid. They vary in texture from heavy silts to clays. They possess a low content of organic matter. Their lime requirements vary from six tons to nine tons of ground limestone per acre. Their content of available and potentially available phosphate is low. Their content of available and potentially available potash is high.

Analysis of a typical sample of the subsoil occurring at the Sophia Experiment Station shows that the soil is a neutral clay of low organic matter content. The supply of available and potentially available phosphate is low. The soil content of available and potentially available potash is high.

Examination of the soil samples obtained from Waranama indicates that the savannah soils are very deficient in plant nutrients, conditions which are reflected in the mineral contents of the savannah pasture grasses. The topsoil samples of the coastal alluvial clay are deficient in lime and phosphate. Their content of organic matter is low. These soils, however, contain adequate supplies of potash.

8. *POSSIBLE MEANS FOR IMPROVEMENT OF SAVANNAH PASTURAGE.*

Analysis of the principal pasture grasses of the Waranama savannahs show that they are markedly deficient in the main nutritive elements. It is hardly surprising that cattle, remaining in this area for any length of time, become emaciated.

The problem of supporting cattle upon this ranching area may be attacked along two main lines.

(a) The manurial treatment of the soil with a view to improving the mineral content of the pasture.

(b) The feeding of supplementary mineral rations to the stock.

The method of improvement suggested in section (a) may be of use upon the coastlands of the colony, where the fertiliser requirements are comparatively low and where there are adequate transport facilities. It is probable that, upon the cheap land of the savannahs where transport is expensive and difficult, the manurial treatment of the soil will not be an economic proposition. Analytical examination of typical savannah soils (DCP XIV, XV, XVI, XVII) indicates

that they require dressings of limestone, potash and phosphatic manures and the incorporation of organic matter, a fertiliser programme which may well cost more than the capital value of the land itself. It has been suggested that the water holes of frequent occurrence on the savannah, might be drained and planted to suitable fodder crops. These soils (*vide* D 74, 75, 78 & 79) are heavier in texture than the savannah soils and contain slightly larger supplies of total and available phosphate. It will be seen that from the analysis of the present covering ("Pan" grass) that this soil phosphate status is not reflected in any marked increase in the phosphate content of the grass. The soils are markedly deficient in calcium, and would require dressings of limestone varying from nine to twenty-eight tons per acre, quantities outside the range of economic application.

It has been suggested by the Government Botanist that other species of grass (e.g., Wynne grass and Sudan grass) might be introduced. While analysis of samples of such introduced grasses would be of interest, it seems probable that no species of grass is likely to assimilate an adequate amount of phosphate, calcium and other necessary minerals, from a soil so deficient in plant nutrients.

It is apparent that the pasturage of the Rupununi is superior in feeding value to that occurring at Waranama, for, in the former area, cattle will breed, while, in the latter area, attempts at cattle breeding have proved a failure. The establishment of an experimental area at Waranama should be postponed until officers of the Department have had the opportunity of discovering the factors responsible for the superior feeding value of the Rupununi pastures.

Analysis of young grass springing from recently burnt areas indicate that this practice does not improve the mineral content of the pasture. The young grass, containing a slightly higher content of nitrogen, is perhaps more palatable.

The cattle of the Berbice savannahs show a pica for bones, and it is suggested that regular bone meal feeding should be commenced.

It should be pointed out that, were the cattle confined to a more limited area than is at present the case, the feeding of bone meal would not be without its effect upon the phosphate status of the soil, for any excess above the requirements of the animals would be voided and would tend toward the increase of the soil available phosphate. Further, such an arrangement with its consequent closer, grazing would perhaps improve the nitrogen content of the pasturage.

A consideration of the results of the examination of the grasses growing upon the heavy clay soil of the coastal alluvial belt shows that they are, in general, deficient in calcium, phosphate and nitrogen. The deficiency of lime and phosphate might be removed by manurial applications or by the feeding of bone meal. These suggestions should form the basis of small scale trials.

The work of Woodman, at Cambridge, has shown that young, closely grazed pasture grass is much superior to the best quality meadow hay and compares favourably with a concentrate of the nature of linseed cake in respect of its con-

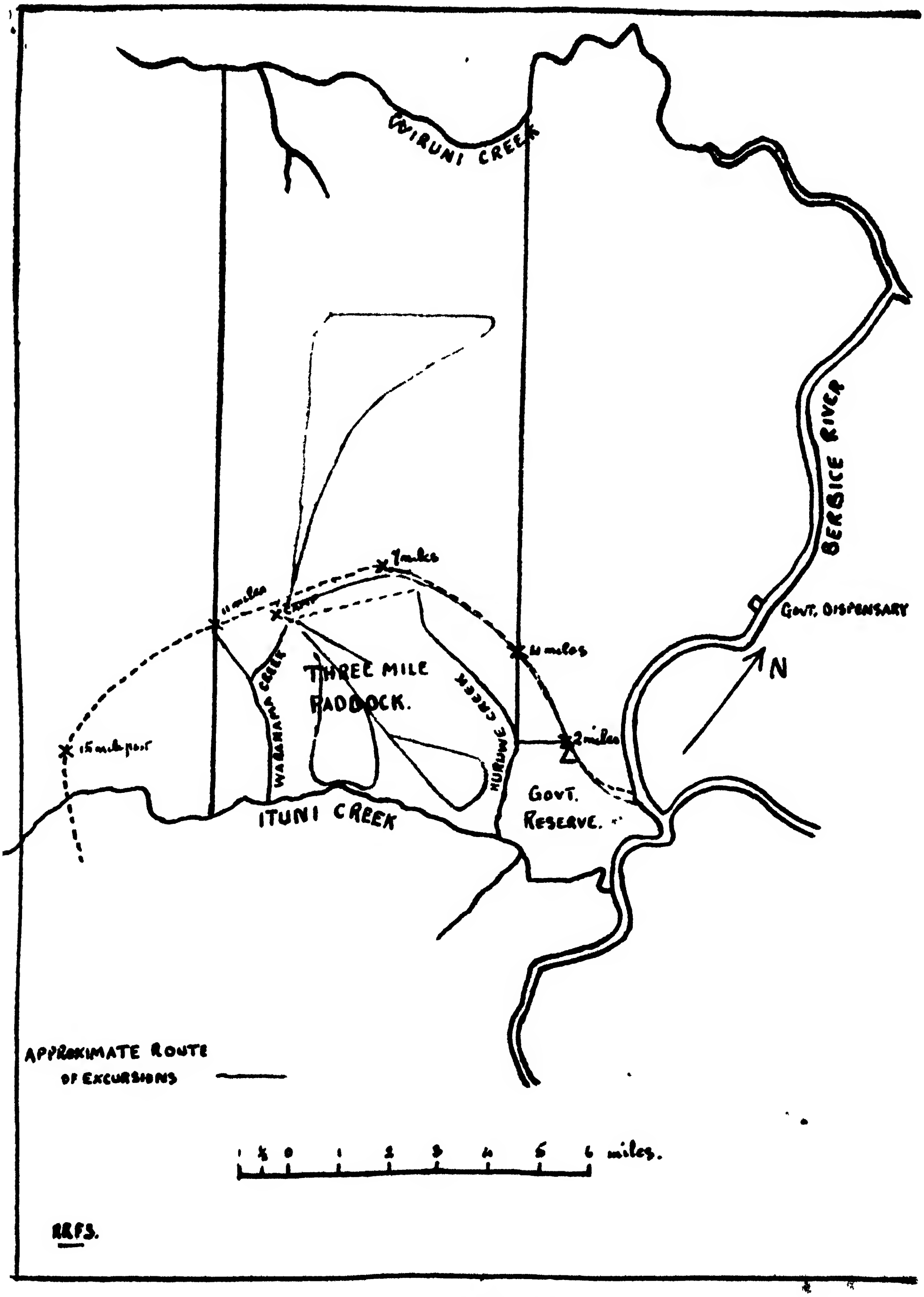

FIG. V.—SKETCH MAP OF WARANAMA RANCH.

tent of nitrogen and its digestibility It is probable that the introduction of a system of close-grazing upon confined areas of the coastlands of British Guiana would do much to overcome the deficiency of nitrogen indicated in the analyses here reported.

9. *SUMMARY.*

The soils and pasture grasses occurring upon the Waranama cattle ranch, Berbice River, have been sampled and examined. The soils consist, mainly of an acid sand, deficient in lime, phosphate, potash and organic matter. The grasses of the savannah, all of a xerophytic type, are markedly deficient in essential minerals. The improvement of the pasture grasses by the application of manures to the savannah soils is not advocated, in view of the fact that the undertaking would probably prove uneconomic. It is suggested that the most promising solution is the regular feeding of bone meal to the ranch cattle. The rectification of the mineral deficiencies of the pasture grasses of the coastland by manurial applications is, perhaps, worthy of field trial. An experiment to investigate the effects of close grazing upon the pasture grasses of the colony might also be undertaken.

I wish to acknowledge indebtedness to Mr. C. L. C. Bourne, who, with the assistance of Mr. L. A. Robinson, has been responsible for the majority of the pasture grass analyses here reported.

INVESTIGATION OF RANCHING PROBLEMS OF THE WARANAMA SAVANNAH, BERBICE RIVER.

By

MAJOR T. BONE, O.B.E., M.R.C.V.S.,

Government Veterinary Surgeon

Waranama Ranch, owned by the Rupununi Development Company, is part of one of the large savannahs in the Berbice River district; it is said to be typical of all the savannahs in this area.

Mr. J. H. Haly, a Director of the Rupununi Development Company and manager of Waranama and coastal ranches, acted as guide and gave information regarding local conditions and management.

The Waranama Ranch is used as a rest and grazing camp for cattle which are being transferred from the interior to the coast.

During the dry weather months of October, November and December, and again during April and May, mobs of oxen consisting of 500 to 600 head are driven along the bush trail from Rupununi to Waranama. The cattle arrive in bunches of about 100 head. Their numbers are checked and the animals are rested in a corral. The day following the arrival of the last bunch, the cattle are turned loose on Waranama; the animals form themselves into bunches of 50 to 60 head and spread over the savannah. At intervals, according to market requirments, 50 to 60 head are despatched by steamer from Waranama to the coast.

During the journey along the bush trail the animals obtain very little food, and arrive at Waranama in a tired condition. They soon recover from the effects of the drive along the trail, and are then in fair condition. They retain this condition provided that they are not kept on Waranama more than a few months. If there is some delay in despatching them to the coast, and the animals have to be retained for a long period on this savannah they lose condition and become emaciated. In some instances, it is said, emaciated animals have recovered their condition, but if still kept on the ranch they have again become emaciated and then invariably died.

There is said to be no difference in the condition of the Rupununi cattle which arrive during October, November and December, and those which arrive during April and May. Mr. Haly stated that the pasture on Waranama was more or less the same all the year round,

Near the homestead there are a few acres of Bahama and Para grass which are used as fodder for the working horses. Uba cane is being tried, and it is Mr. Haly's intention to increase the acreage of the Bahama and Para grasses. These cultivated grasses are grown on the edge of forest land.

Bone meal is fed to working oxen in a small corral, but only one ox feeds itself—the others have the meal administered to them when men are available for this work. A few of the working oxen were seen chewing bones found on the land.

An inspection of the ranch showed a good water supply; numerous water-holes exist, and most of the creeks, of which there are many, are easily accessible.

The soil is of a sandy nature and the pasture of very low nutritive value.

Miles and miles of pasture were untouched by stock. Mr. Haly stated that unless the grass was burnt the animals would not eat it, so the custom is to burn old grass all the year round. Two or three weeks after the old grass has been burned, young shoots appear. These are grazed by the cattle for a few days only and then the animals search for other burned areas.

Here and there, in the neighbourhood of water-holes and near creeks where the soil appears to have some humus content, the pasture is well grazed, but it is very sparse. Small stretches of land which appear to have a harder surface than the general soft sandy areas are also well grazed. The grasses growing near water-holes and creeks and on the harder patches of land are of the same kind as those found everywhere on the savannah.

In a "muri," a curious formation of a white sandy nature—there are several of these—a different kind of grass is found which is eaten by stock, but it is not in great quantity. A bush growing in a "muri" is also eaten to a small extent

As a "muri" is invariably near a water supply, it is probable that the grass and bush are eaten when animals are going to and from water, and that neither is greatly relished by stock. It was evident that the animals travelled very many miles each day in search of food, and that it was only in the places mentioned that the pasture was grazed.

Most of the stock on the ranch are in only fair condition, occasionally one in good condition was seen, but there are many which are emaciated. While there was every evidence of malnutrition, there was no evidence of disease.

The soil everywhere is poor, and consequently the pasture is non-nutritious.

Mr. Haly stated that an attempt to keep breeding stock on this ranch failed. One hundred head of cows and heifers were transferred from Rupununi, but they lost condition rapidly and died.

Waranama as a Rest and Grazing Camp:—As the savannah is at present, cattle transferred from the superior grazing of the Rupununi District to

Waranama are certain to lose condition. During the dry season the percentage of phosphorus in pasture is at its lowest. The Rupununi cattle have to be transferred during the dry season. The percentage of phosphorus in Waranama pasture is probably always very low, and during the dry season must be almost non-existent.

The cattle are turned loose on to a wide area of approximately 78 square miles, and have to discover the small areas where the grazing is moderately good. Even cattle which have been on the ranch for months spend much of their time travelling in search of food.

As all the savannah is alike, an experiment of concentrating these small mobs of 500 to 600 head in one large paddock is worthy of trial. The present "Three Mile Paddock," a name given because of its position and not size, would be suitable for this purpose. If no burning is practised in this paddock, the small leguminous plants and other grasses which grow between the tufts of the common grasses will be given a chance to develop. Generally speaking, only about 60 per cent. of the soil is covered with herbage.

Placing a lick of salt and bone meal in log troughs a short distance away from the known favoured grazing areas may attract the animals and help to increase the areas cropped. Close grazing will lengthen the period during which the herbage is of high feeding value, and in a limited area like the "Three Mile Paddock," the useless marching of miles and miles in search of food will be checked.

The division of the "Three Mile Paddock" into smaller paddocks each containing one of the known favoured grazing areas and arranging for the animals to be transferred from paddock to paddock according to their grazing capacity, would be an immediate solution of the present problem of keeping the animals in condition, but possibly this is not economically possible at the moment.

The Savannah as a Ranching Area:—The only present qualification is an excellent water supply. As already stated, favoured grazing areas exist near water-holes and creeks, and on small areas here and there, but this pasture is not sufficient to support many head of cattle, and probably would not maintain breeding stock at all.

Indians clear the bush at the edge of the forest land and are able to grow crops for one to two years. A few head of cattle kept near the Berbice river keep in good condition; and Mr. Haly has shown that Bahama, Carpet and Para grass will grow on the edge of the forest. But the herbage of the savannah is non-nutritious. The practice of burning the old grass will not improve the pasture, but in the present circumstances nothing else can be done.

It is interesting to note that Mr. Haly states that animals which graze on burned areas do so for only a few days, and that they leave these areas when there appears to be grass growing. It seems possible that in addition to cropping young shoots of high mineral content, there is also a certain amount of ash which

is licked up by the cattle, and that when this is exhausted, the cattle search for fresh grazing areas. A deficiency of phosphorus is shown by the animals chewing bones found on the land.

The Government Ecologist made a careful inspection of the land and took many soil samples, his analyses may reveal some redeeming feature not apparent to the naked eye.

The Government Botanist made a careful selection of all the herbage and may be able to discover some grasses or bushes which will live on this kind of soil and be relished by stock.

As a great area of land is invölved, it may be advisable to establish a Government experimental grass farm on this savannah.

Rupununi Cattle :—Compared with other cattle reared on free range these animals are comparatively tame. Most of those seen on the Waranama Ranch were young and well grown.

As beef cattle, their conformation leaves much to be desired. Generally, the fore-quarters are heavy and the hind-quarters light. Amongst those seen on Waranama, it appeared that most of the emaciated animals were of brown colour. On the other hand, the few which appeared in good condition were speckled white. Pica is said to be common in certain parts of the Rupununi, and if the brown cattle come from pica areas, it may account for their poverty compared with the other animals. At the same time, the constitutions of these brown cattle may be weak, and if this is so, it is advisable for Rupununi Ranchers to practice selection when breeding.

Mineral Deficiency :—There is clinical evidence of phosphorus deficiency. There may be other mineral deficiencies which Mr. Follett-Smith's analyses may reveal. In the meantime, I suggest that a lick of 1 part salt and 3 parts Bone-meal should be fed in log-troughs.

COCONUT CULTIVATION IN BRITISH GUIANA.

BY

H. D. HUGGINS, D.I.C.T.A.,

Asst. Agricultural Superintendent, Demerara.

The coconut plant is one which has, in different countries, adapted itself to a wide range of conditions. Among the factors which usually are associated with the best crop returns are :—a light, friable soil with an alkaline reaction, an annual rainfall of about 70 inches, good surface and subsoil drainage, regular superficial cultivation.

In British Guiana, coconuts have been established in heavy clay soils acidic in reaction—with the exception of the moderately extensive sand reefs on the East Coast, Demerara, West Coast, Berbice, and the Corentyne coast—or on the peaty or pegassy soils of the Pomeroon; the mean rainfall of the colony varies from 81 to 103 inches; during the rainy seasons the soils are frequently in a water-logged condition over a considerable period ; it is not the custom to practise any cultivation except the clearing of undergrowth twice or three times a year in coconut areas.

It can therefore be deducted that the state of the local coconut industry is not satisfactory; nevertheless, the acreage in 1912 in coconuts was double that in 1905 ; export of coconut products in 1929 was nearly 20 times greater than it was 10 years ago, and extension of the crop continues.

Since the coconut has been and is being planted under conditions that are, in certain instances, patently unsuitable, and since the crop has been proved to be remunerative (a fact which is indicated by the extension which has taken place), it may be of some local value to discuss the chief considerations relative to cultivation under the conditions existing in British Guiana.

SOILS.

Many coconut cultivations have been established on heavy soils neither through ignorance nor from preference, for probably every local planter has been convinced by experience that a light soil is the most suitable type for coconuts. Coconuts are one of the few permanent crops of those tried that do still give monetary profits in British Guiana. There has been the tendency to increase the area in this crop ; the available sandy soils, in comparison with clay, are small ; it is thus that a considerable area of the latter type, although known to be less suitable, has been and probably will continue to be planted up in coconuts.

The case of British Guiana is not unique, and there are other countries in which this crop has been established on heavy soils[1]; in such cases, coconuts have proved themselves to be notoriously poor yielders, and can only be cultivated profitably if the greatest attention is paid to estate sanitation—especially drainage. Under local conditions, the last named operation is not easy, and is usually expensive. If a proprietor desires to cultivate 400 acres, the cost of empoldering this area (a charge over and above that necessary for internal drainage and one not arising in a naturally drained country) is approximately $8,000.00-$9,000.00. The cost, per unit of land, is so high that the proprietor can ill afford to cultivate a part only of his empoldered area ; hence, although the sandy soils occurring only as 'reefs' between the clay have been prepared and first planted, ventures have also been made on the clays.

The practise of establishing coconuts on abandoned cane land in British Guiana has been frequently deplored by previous workers, and with justification. It is not conceivable that high yields can be obtained except by very intensive cultural and manurial operations. Nevertheless, cane lands, abandoned though they be, have been already empoldered and the coconut proprietor is relieved of an initial expenditure, which the above figure ($9,000,00 for 400 acres) indicates would normally be appreciably beyond the means of the small cultivator. This appears to be a possible explanation for the persistence in a practice which has been so frequently condemned.

Albeit, there are instances in which this crop has been established under circumstances (e.g., badly drained clays that are frequently flooded) which must inevitably be a cause of failure. Mention must also be made of the pegasse soils which, as in certain cases in the Pomeroon, have been planted with this crop. Experience has shown that the palms under such conditions are short-lived, and that these soils should be avoided.

In short, the position with reference to the selection of land for cultivation is that planting should be done preferably on the sand reefs, but successful crops may be obtained on the clays when the drainage and general sanitation are thorough enough.

Selection of Seed Nuts.

Selection, as done in British Guiana, is usually not of a complicated nature and consists almost solely of obtaining seed nuts from fully mature trees which when nuts are being collected for sowing, appear to be good bearers of a suitable type of fruit. Unfortunately, there is frequently less trouble than this taken, and seed nuts may be merely gathered from the piles of nuts accumulated from an ordinary harvest.

Seed selection is one of the features most deserving of attention in local coconut cultivation. As the area of land occupied per tree is compartively great

1 Tropical Agriculture, Vol. I, 1924, pp. 126.

and as the crop is of a permanent type, it is essential that the best available planting material be procured.

It is possible that the lack of knowledge of the yield of different varieties, of descriptive characters by which they may be identified, and of the degree to which they may be expected to breed true to type may be factors tending to give the planter little encouragement to attempt selection. The writer assisted in some observations (account unpublished) on the rate at which the inflorescence of 25 coconut palms appeared. These observations were carried on over a period of 3 months and not once did the opening of male and female flowers coincide on the same plant ; on the same inflorescence the female flowers opened 3—6 days after the last male had been shed ; new spadices opened up two days onwards after the female flowers (which remain receptive for 24—30 hours) of the preceding inflorescence had opened. The indications are therefore that self-pollination must rarely occur, under these conditions, among the 'tall' palms which are the type almost entirely cultivated. Hence, it is apparent that trees which look very much alike will differ constitutionally, and seedlings from the same parent tree will vary, to an extent as yet undetermined, on account of cross-polination.

Nevertheless, there is much which has been gained in coconut cultivation by selection and for practical purposes the following is a system which, if followed, may be relied on to give as good results as may be expected when the present lack of data on coconut yields is taken into consideration.

The parent trees should be mature, not less than 25 years old, and not more than approximately 40 ; only trees which are growing under ordinary estate conditions should be chosen, as those observed flourishing near to dwellings, compost heaps, on the margins of fields, and in advantageous positions with regard to light and drainage, owe much of their apparent vigour to their favourable surroundings.

The ideal condition would be to have a tree-record by means of which the copra yield of each tree could be known, and, by a process of elimination, ascertain which are the best trees on the estate. This cannot be done hurriedly, nor can it be done economically on a large scale, but the field from which the highest returns are obtained should be selected, every tree in a block of suitable size in that field numbered and a record kept of the number of nuts collected from each tree. Three or four pickings of monthly intervals will give indications of the poorest yielding trees which can be eliminated, and the number, retained for observation, considerably reduced. The most prolific trees having been discovered, copra is separately prepared from the ripe nuts of each tree and then the weight of the copra produced per nut estimated.

While the above scheme may be good, it is rather too ambitious to be adopted readily in the system of coconut cultivation which is generally practised in this

colony; the following general hints, although less comprehensive, may be more favourably considered and so be of more practical utility.

Select seed nuts from a tree which has short interspaces between consecutive leaf-scars that are deep and close together as these characters are indications of regular and heavy bearing. A parent tree should be one containing a large number of leaves (these may vary from about 25 to 40); apart from other reasons, since each leaf normally bears a bunch of fruit in its axil, the greater the number of leaves, the greater will the number of bunches produced.

Select trees bearing a medium sized rather than a large nut in which the percentage of 'meat' is large. It is even preferable to select from the size of the nut rather than from the size of the fruit, for, in some types, the husk is so thick that an erroneous estimate may be made of the size of the nut (and so of meat) within. As to the actual shape of the nut, such divergent views are given that it is probably not a character deserving of too great attention.

NURSERY.

This phase of work is of especial importance in the local industry, for not only is a nursery used prior to the establishment of a plantation, but the death rate of growing trees is so high that—except the cultivated area be very small—the need for replacements necessitates a constant nursery supply.

The system generally adopted here, and which appears to be satisfactory, is to place the selected seed nuts 1 foot x 1 foot apart in the nursery. This is usually situated not far from the main buildings, and, although it might appear that it would be preferable for the nurseries to be closer to the planting sites, the concensus of opinion is that the advantages obtained from easy and constant observations of the young seedlings warrant the continuation of the present custom.

The soil of the nursery should be light and friable, and surface drains about 9-12 inches deep should be dug approximately 8 feet apart in order to give the young plants the necessary drainage. When the weather is dry, light shade (e.g., by means of plaited coconut leaves) or a straw mulch should be supplied to the young plants. Too much shade must, however, be avoided, as otherwise the plants become 'leggy' and adapt themselves, with difficulty, to the change in conditions when they are transplanted.

The rainfall in this country is abundant, but is not evenly distributed throughout the year, so that—although in some cases seed nuts are merely placed on the surface of the soil of the nursery and light shade placed over them, as is frequently done in localities with high humidity—it is usually the custom to cover the seed nuts with soil so that only the top of the nut can be seen above the ground.

It is necessary to make reference to the beetle pest, known as "Cockles" (*Strategus aloeus L.*), which influences the position in which nuts are placed in the nursery. When nuts are 'set' in the soil, the usual custom is for them to be

placed on their sides; in many districts locally, the nuts are invariably "set" upright so that the end with the germ is uppermost. When the latter is done, the damage by this pest is said to be more readily detected and control measures more easily applied. A disadvantage when the seed nuts are placed in an erect position, is that the scale leaves tend to harbour fungi and scale insects, and it is generally admitted[1] that, under normal conditons, better results are obtained from planting the nuts on their sides. Nevertheless, the ravages of the pest can be severe, often resulting in the complete destruction of the young shoot, and the practical adjustment to conditions persists.

If a nut is examined, it will be observed that there are three sides, and that one is wider than the other two. If planting on the side is practised, the nut should be so placed that the wide segment is uppermost as it is the latter which has the germinating eye. Manure is not generally applied to nurseries locally, nor is the practice considered advisable. The seed is amply supplied with plant food, and manure merely tends to encourage an excessive formation of fibrous roots; also, if organic manures be used, insect pests may be encouraged.

The period during which seedlings should be left in the nursery, before transplanting, varies. Germination takes place in 3-6 months, and on many plantations the plants are transplanted in 9-12 months. The advantage of planting at such an advanced stage seems to be that selection of the right type of seedling for planting can be made, 'leggy' and other undesirable types discarded. There are, however, planters who prefer to transplant at a much earlier age. It is claimed that when the seedings are young (*e.g.*, when the shoot is 12″-15″ high) their roots are less firmly established in the seed bed and so the shock (of transplanting) is not severe; at this stage, as the 'meat' has not already all been utilised, the young plant can better withstand unfavourable conditions in the new environment. This latter opinion the writer has heard frequently expressed, especially on the West Coast of Berbice, and it is worthy of note that these also have been the conclusions drawn form certain Philippine experiments (loc. cit.).

Field Culture.

The seedlings should not be planted closer than 30 feet x 30 feet apart. When conditions permit, the position of the holes should be lined out before the drains are dug. The most desirable system is to practise diamond-shaped planting, each hole being at the corner of an equilateral triangle whose sides are 30 feet long. In this method, the plants are allowed sufficient leaf and root space and there are fifty-six trees per acre. When square planting in practised there are only 48 plants to the acre. This difference is equivalent to about 400 nuts per acre per annum in favour of the diamond or 'quincunx' planting. In very many cases, however, coconuts are planted locally on land that was formerly laid out for canes with drains 30-36 feet apart. Diamond-shaped planting (with a spacing

1 ESPINO, R. B., Philippine Agriculturist, Vol. XI. No. 6 pp. 197.

of 30 feet) is therefore impossible, as the drains will interfere with the layout unless certain rows are planted very close to the drains and this is inadvisable. Square planting is therefore the general rule in British Guiana.

Drains of different dimensions are made in different localities, varying as the conditions may demand, but, in general, drains 3 feet wide at the top, graded to 2 feet at the bottom and 2 feet deep seem, normally, to be satisfactory ; the average cost of digging such drains is about 12 cents per rod.

Nuts are 'set' in the nursery so that transplanting may be done in either or both of the rainy seasons (April-July and November-January), but November to December planting is preferred because the dry season which follows is a short one and the young seedlings will not be exposed to a too prolonged dry period before the April rains begin.

Usually, a hole is dug of such depth that when the seeding is transferred the nut can be just covered with soil. It would, however, be wiser to have the holes more thoroughly prepared. When the beds have been lined, holes (3 feet square and 2 feet deep are recommended) should be dug. The holes should be left open for some time, preferably for 8-10 weeks, and refilled with surface soil so that, when seedlings are put in, the nut is a little below the original level of the field. The plant should be placed in the middle of the hole, the space around the nut filled in and the soil firmly pressed down so that there is no depression in the immediate vicinity of the seedling in which water is likely to stagnate.

This soil should be mixed with farm-yard manure but the latter, under existing local conditions, would frequently not be available. Nevertheless, this is a critical period[1] in the life history of the plant, as, in many cases, the plant has ceased to get nourishment from the reserves in the nut, and, moreover, the severing of young roots and the actual operation of transplanting constitute a check which necessitates the application of a quick acting fertiliser when the plants are set in the field. A mixture which has been recommended in other countries is :—

150	lbs.	Superphosphate.
150	„	Nitrate of Soda.
50	„	Nitrate of Potash.

This should be throughly mixed and 2 lbs. applied to each hole.

The seedlings having been transplanted, the custom is, in British Guiana, to fork around each plant as soon as it is well established (*i. e.*, about six months after). Intertillage is obtained indirectly, for 3-4 years after planting, by the cultivation of catch crops. Such catch crops are usually not planted and owned by the proprietor, but belong to renters. The system of renting young orchard fields to farmers for the growth of quick growing crops has evidently been adopted both because of the dues received and of the general cultivation which is necessarily given to the soil. In the case of coconuts, however, the disadvantages which result

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[1] DASH, J. S. Agr. Jour. of British Guiana Vol. II. No. 1. pp 15.

from the breaking in and disrepair of drains, the depressions in the beds caused by the planting in mounds of such crops as potatoes and yams, and the haphazard cultural operations practised by tenants detract more from the value, which should be obtained from such a system, than may at first appear.

The extent and frequency of the cultivation of fields in which coconuts are established are subjects on which divergent views are held and on which a pronouncement for local conditions should be made with caution. It would appear, however, that what evidence there is indicates that the economic advantages to be gained locally from clean cultivation are questionable. Harrison and Stockdale[1] considered that, after about six years, coconuts required little cultivation, but that drainage should be attended to and weeds cut down and used for mulching purposes. Dash[2] was of opinion that, under tropical conditions, clean cultivation and no attention to the vegetable matter content of the soil led to disastrous results and that the most successful tropical orchardists had learned fully to appreciate the value of the organic mulch. There are definite figures[3] given for certain estates in Portuguese East Africa where a yield of 0.5 ton of copra per acre is obtained by plantations which practise intensive cultivation as against a yield of 0.2 ton per acre without much cultivation. There is a difference of 0.3 ton which is equivalent to a gross profit of $24-$30 per acre. This figure seems low, and would not offer sufficient inducement to the local planter to maintain his fields in a high state of cultivation unless the labour supply on coconut estates were much increased and the cost of cultural operations (possibly by the use of implemental tillage) considerably reduced.

On the other hand, it cannot be contended that the almost complete state of abandonment, in which a large percentage of the coconut cultivations in British Guiana is kept, is satisfactory, and a practice which is likely to be profitable is the more general use of green manure crops between the rows of coconut trees. If a vigorously growing crop such as Black Bengal Beans (*Styzolobium atterimum*) were selected, weed control could be very considerably aided, the soil could be protected from the mechanical beating action of rain and from excessive heat of the sun. At intervals, the green material should be ploughed in and incorporated with the soil in the middle of the beds. This would increase the general fertility of the soil and especially the content of humus. Apart from other considerations, the mechanical effect of the decomposed organic material incorporated would be very desirable, especially on heavy impervious soils on which this crop has been in many instances planted. It should be noted that after Bengal Beans have been well established they will re-seed the area and that there should normally be no re-current costs for sowing.

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[1] HARRISON, J. B., and STOCKDALE, F. A., Jour. of Board of Agr. of B.G. Vol. V. No. 4. pp. 206.

[2] DASH, J. S., Trop. Agr. Vol. IV. No. 8. pp. 145.

[3] Tropical Agriculture Vol. VI. No. 2. pp. 51.

Reference may be made at this stage to the care of surface drains. All drains should receive attention and where necessary re-conditioned every year. The drains should, however, be freed of all weeds and grass not less than three times per year, and stoppages, caused by the collpasing of the sides by excessive silting, removed.

YIELDS AND COSTS.

Picking is as a rule done at intervals of 10-12 weeks. The pickers should be experienced, as it is essential that they recognise the fully ripe nuts. A good picker can usually distinguish accurately between the ripe and immature nuts simply by their appearance, but, when there is any doubt, tapping with the knuckles is resorted to. The ripe nuts when so tapped emit a hollow sound as against a dull less resonant note by the younger nuts.

The local census returns indicate that the average yield per tree per annum is not much more than 15 nuts. Such a low figure is due to the not inconsiderable coconut area that is in absolute and complete abandonment. Many such cultivations were, at their inception, not thoroughly drained and in unsuitable enviroment (e. g., heavy clays, pegasse) and as they grew older were deprived of all cultural operations. Low returns could therefore be expected, but there are many coconut plantations on which very much more satisfactory figures are obtained. On the West Coast of Berbice and on one estate on the Corentyne, the writer is convinced that the yield is frequently more than 70 nuts per tree per annum and there is an appreciable area on which the normal annual yield is about 40 nuts per tree.

The following yields and costs which are based on figures collected on a number of estates in different parts of the colony may prove interesting :—

Yield per acre of moderately good estate approx.	2,000 nuts.
Average of 5,000-7,000 nuts yield ...	1 ton of copra.
Yield of copra from 1 acre	750-800 lbs.
180-250 nuts (mixed) give (by existing primitive system of extraction) ...	1 tin or 4 gals. of oil.
Yield of oil from 1 acre	40 gallons (1 drum).
Cost of picking and transporting to yard per 100	16 cents.
Cost of picking, transporting and 'peeling' of 100 nuts	20-26 cents.
(Nuts are always 'peeled' when they are sold as such and not converted into copra.)	
Cost of peeling per 100	6-7 cents.

Cost of "digging" meat from shell per 100 ...	6 cents.
(Frequently, however, when copra is being made, the nuts are not 'peeled' but the husk and shell are broken with a pickaxe in one action, and then the meat removed. By this method, a saving of 40 cents—60 cents per thousand nuts is effected.)	
Cost of drying 1 ton of copra	$ 5.12

COPRA.

This is the commercial term of the dried meat or kernel of the coconut. Previously, comparatively small quantities of copra were shipped from this Colony, the trade being almost entirely in nuts, but, as the table below indicates, the production of copra has steadily increased.

ANNUAL EXPORT OF NUTS AND COPRA.

	1907-26 (Average)	1927	1928	1929
Nuts (thousands)	1,623	334	322	638
Copra (cwts.)	4,745	23,266	70,017	75,187

In most cases, nuts are picked, but rarely only fallen nuts are collected. Where the latter is practised the operation should be carried on at regular intervals and as complete a collection as possible made each time, otherwise some of the nuts remain on the ground, begin to germinate and give rise to a poor quality copra which is pale and does not possess the characteristic colour of high grade copra. Where, however, the nuts are picked—and the practice is recommended—they should be stored for some weeks after being picked, as stored nuts give the best quality copra.

Almost all of the copra which was formerly produced was sun-dried, but the erection of small hot air dryers is becoming increasingly common. One of the essentials in copra making is that the kernels do not become wet after drying has started ; if this occurs, the copra will not keep, readily develops moulds and becomes rancid. The dry season is neither sufficiently well marked nor normally so prolonged as to permit sun drying being otherwise than a most uncertain procedure.

The hot air dryers in use are of very simple design. At one end of the dryer a furnace is situated, from which the hot gases are conducted through the furnace by boiler tubes. The gases from the furnace are not liberated in the chamber, but escape through a chimney at the opposite end of the dryer so that the temperature of the air in the chamber is raised through the heating of the

tubes. As the kernels must be dried with hot dry air, it is essential that suitable ventilation in the chamber be supplied. This is done in many cases by placing, through the side of the chamber, a tube which helps to connect the interior of the dryer with the atmosphere. If the advice of an engineer, experienced in copra-drying, were available, the efficiency of these dryers could doubtless be considerably enhanced. Until such time, however, as co-operative movements may make it possible or until the average size of the plantation is greatly increased, the present type of machinery is not likely to lose favour—in such circumstances simplicity and initial expenditure have much influence.

Coconut Oil.

Oil is not made locally from copra. The fresh kernels are removed and grated. Usually, the grater consists of perforated tin placed around a revolving rotary drum which is operated by a low horse power (e.g., 3 h.p.) oil engine. When continuous work is done 200 nuts (i.e., enough to produce one tin or 4 gallons of oil) in 30 minutes is a fair estimate of the rate of grating.

The grated material is then hand-squeezed, a liberal supply of water is added, the mass washed and squeezed again. Approximately 40 gallons of water are used in the washing and squeezing of 200 nuts. The washings are then settled in drums for about 16 hours. The oil separates, floats on the top, is skimmed off and boiled. The clear oil is strained off and the residue is then subjected to strong pressure, generally by means of a jack-screw.

When the 'milk' from 200 nuts is left to stand for 16 hours, about 6 gallons of oil and water emulsion are obtained, and this, on boiling, is reduced to about 4 gallons. Frequently, a small amount of salt is added to the washings as the sodium chloride in solution is said to hasten the settling process. As the oil is a colloid in suspension, is to be expected that the oil separation would thereby be facilitated.

Little comment is necessary on this method. It is crude, not economical, and the expression of oil is extremely low. A good grade of oil is produced, but the production costs are so high that there is little encouragement to increase the present output.

Diseases.

As a result of planting on unsuitable land in the first instance and subsequent neglect, large numbers of coconut trees in the Colony are lost from wilt disease (formerly known as 'bud rot'), a condition primarily brought about by unfavourable enviromental conditions, and entirely comparable in cause and effect with the "Bronze Leaf Wilt" of coconuts which has recently been engaging attention in Trinidad.[1] Contributory factors to the occurrence of the disease

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[1] BRITON-JONES, H. R., Wilt Disease of Coconut Palms in Trinidad, Supplement to Tropical Agriculture, December 1929.

are insufficient nutrient supply, water-logging, and poor cultivation in general, the latter resulting in a bad condition of the soil and an overgrowth of weeds, which block the drains and compete with the palms to the disadvantage of the latter.

The disease, as mentioned above, is most usually found upon heavy soils, but occasionally appears on sand reefs. The symptoms exhibited by the palm are a yellowing and later bronzing in colour of the leaves, which eventually die and hang down. The outer (i.e., the oldest) leaves are affected first, and then the other leaves follow in succession, the crown of the tree being the last part to lose its green colour. By the time that half to two-thirds of the leaves have died, however, the heart and bud of the tree become involved in a wet foetid rot, which is very evident if an affected tree be felled and the crown split open longitudinally. The bacteria, etc., causing this rot are a secondary factor, and only attack the already wilted and weakened tissues.

As regards other diseases, the Red Ring disease, so serious in parts of Trinidad, has only been reported once in this Colony—a somewhat doubtful case —and is not a factor affecting the crop. One or two minor leaf diseases are known, but these are to be found as a rule only upon palms already weakened by other causes. Another disease, the exact origin of which is uncertain, causes a disfigurement of the outer surface of the nut, but does not affect the contents.

INSECT PESTS.

The four principal insect pests are the Coconut Caterpillar (*Brassolis sophorae*) the Coconut Stem borer *Castnia daedalus*, the Coconut Beetle or Cockle (*Strategus aloeus* L.) and the Large Locust (*Tropidacris latreillei*, Perty).

Coconut Caterpillar—The caterpillars destroy the leaves of the palms at times completely defoliating them. They form "nests" by drawing together several of the leaves on the branches; in these nests they live during the day, emerging at night to feed. They also conceal themselves in the "heart" of the tree. Husks old branches, "bush," etc., harbour the chrysalises.

For the control of the pest it is necessary to remove completely all such branches and nests and to destroy carefully all caterpillars. Also husks, branches, "bush" and other waste material lying on the ground beneath the trees must be collected together and burnt.

Coconut Stem borer—This pest lays its eggs about the leaf-bases of the Coconut Palm and shortly after the larva emerges, it bores into the stem about the leaf-bases and there remains until fully grown, causing in the meanwhile considerable damage to the tree. An attacked tree, when in the advanced stage, shows a peculiar droop of the leaves, bending considerably as if too heavy. In some instances an attack of this kind causes the tree to cease to bear fruit and often proves fatal.

The method of control employed against this pest is the careful removal of all the lower branches by cutting them off as completely as possible from the tree. The "worms" should then be secured and destroyed.

Coconut Beetle or Cockle—These beetles burrow into the lower stem and rooting system of young coconut palms, and, if not removed, will cause the death of the palm. A sickly appearance of young palms often indicates the presence of the coconut beetle. The large sized hole made by the entry of these beetles at the base of the palm is easily detected.

This insect can be controlled if dug out, but, when this is done, care must be taken not to injure the palm. A better way is to pour a mixture of kerosene and water or naptholeum and water into the burrow and this causes the beetles to come to the surface where they may be captured and destroyed.

The Large Locust—Both the adult and immature forms of this insect feed on the foliage of the Coconut Palm. The immature forms being particularly destructive. On the appearance these pests, unless early steps are taken to have them collected and so prevent their egg-laying, would increase abundantly and cause a great deal of damage to this palm.

These insects are controlled by shaking or sweeping them from the foliage and collecting them in convenient receptacles containing kerosene and water, after which they should be buried or burnt.

NOTE.—The paraprapbs on coconut diseases have been supplied by Mr. E. B. Martyn, Botanist & Mycologist, and those on insect pests by the Entomological Division.

THE TOXIC ACTION OF MAGNESIA ON SUGAR-CANE.

BY

MAURICE BIRD, B.Sc.

For many years now, the Sugar Industry of British Guiana, located principally on the alluvial coast lands, has been troubled, at times acutely, by what was more or less vaguely believed to be a form of root disease, emanating from an unsanitary soil condition.

In 1925, it assumed, in one part of the Colony at least, so threatening an attitude that unusual efforts were made to explain the cause. The only definite symptoms appeared to be the withering, and ultimate death of stalks and stools of cane, sometimes in small quantities, sometimes in large.

No specific disease could be diagnosed, but, on analysis of the cane, the writer found an unusual quantity of magnesia, especially in proportion to the lime present.

Four years later, the writer was called to an estate where the "disease" was even more acute, and, here again, the magnesia of cane and soil was still higher, both in percentage and in proportion, to the lime. Indeed, analysis of two samples of the ash of the dead cane gave 24.28 and 25.40% magnesia respectively; both soil and cane showing over three times as much magnesia as lime.

In order to observe the effect of magnesia, when applied directly to sugar-cane, four stools were selected in a section, looking and growing well, and near the roots of each eight ounces of epsom salt (containing about sixteen per cent. magnesia) were buried on the fourth of May, this year.

When the cane was revisited on the fifteenth of the following August, these four stools were found to be dead, while the rest of the field, and section, was apparently growing vigorously.

Two samples of the dead cane yielded the following figures for lime and magnesia :—

			Per cent. Cane	*Per cent. Ash*
1st Sample	Lime ...	...	0.0015	0.131
	Magnesia ...	...	0.0024	0.204
2nd Sample	Lime ...	...	0.024	0.539
	Magnesia ...	...	0.084	1.904

The time of the experiment was one of excessive rainfall, the total precipitation being 41.49 inches, which, by keeping the magnesia solution dilute, should have given the cane an unusual chance to cope with the poison ; its death therefore, under these circumstances, seems to emphasize the danger to cane of excessive magnesia in the soil, which appears to be prevalent throughout the sugar belt of British Guiana, and to stress the importance of using every means available to remove it, and to ameliorate its pernicious effects.

In an attempt to locate the magnesia strata, or to ascertain if there is such a thing, samples of soil through each six inches, were taken to a depth of thirty-six inches. Two such series were taken upon one estate, and two upon another.

Calling these series A, B, C, D, the lime and magnesia percentages, soluble in a 1% solution of citric acid ("available" lime and magnesia), are shown in the following table :—

	A		B		C		D	
	Lime-	*Magnesia*	*Lime-*	*Magnesia*	*Lime-*	*Magnesia*	*Lime-*	*Magnesia*
1st 6 inches.	.074	.056	.135	.069	.107	.081	.093	.018
2nd do.	.069	.040	.117	.093	.087	.032	.102	.011
3rd do.	.084	.098	.100	.096	.091	.049	.125	.011
4th do.	.056	.013	.078	.044	.107	.143	.113	.013
5th do.	.091	.085	.084	.043	.103	.072	.092	.010
6th do.	.089	.022	.025	.074	.144	.076	.084	.009

There seems to be, however, little connection between depth and quantity of magnesia, this latter probably varying with the fluctuations of the currents of water which, in past geologic periods, brought the magnesium silicate (for it was originally evidently in this form) from the interior of the continent and deposited it in its present position.

As the fields from which A & B were obtained had some dead cane, two samples of this were taken and analyzed for lime and magnesia, yielding the following figures :—

		Per cent. Cane	*Per cent. Ash*
1st Sample	Lime	0.14	2.55
	Magnesia	0.86	16.06
2nd Sample	Lime	0.13	2.47
	Magnesia	0.84	15.67

The field from which series D was taken showed no signs of dead or dying cane, which was to be expected from the good lime-magnesia ratio shown throughout.

The removal of the magnesia would be comparatively easy, but for the impermeability of these stiff clays which retain it with great pertinacity.

All forms of ploughing to loosen the soil, and allow of the magnesia being leached out, are therefore highly desirable, as well as the incorporation of all forms of organic matter, for the production of humus and the promotion of this same loosening and leaching effect.

Obviously lime, to maintain a satisfactory lime-magnesia ratio, is very necessary; probably it should be applied whenever analysis does not show twice as much lime as magnesia.

Also, if applied in the form of hydrate, or tempered lime, it precipitates much of the magnesia as an insoluble and harmless compound.

To summarize, if the small quantity of magnesia, in the apparently harmless epsom salt, can cause death, then the magnesia diffused throughout these alluvial lands, to which attention is drawn, must be held accountable for innumerable disappointing yields from crops which in their early state of growth gave promise of excellent returns.

AGRICULTURAL LEGISLATION.

1. INTRODUCTION BY THE DIRECTOR OF AGRICULTURE IN THE LEGISLATIVE COUNCIL OF A BILL FOR THE REGULATION OF THE EXPORT OF RICE.

In moving the second reading of the Bill, Professor Dash said it was hardly necessary for him to stress at any great length the necessity for legislation of this kind. The subject had been ventilated very thoroughly for some time. It was desirable, however, to make clear the Government's position in the matter.

In the first place there could be no doubt of the effect of grading as regards the general toning up of the industry and as an incentive to producing the best and improving and extending the colony's markets. This was true in respect of any agricultural product and all progressive agricultural countries were adopting legislation of this kind. In the case of the local rice industry, grading aimed specifically at stabilisation of the existing West Indian markets. The common complaint was that buyers were never sure of what they were getting, also it was felt that any measure adopted at this time would prevent undue delay in the development of fresh markets. It would be realised by honourable members that the entry of graded rice under Government aegis provided a hall-mark and a guarantee to the new buyer. The Bill gave the necessary powers to the Governor-in-Council to appoint Inspectors and to make regulations with regard to the manner and method of grading, places and manner of storage, all of which were fully set out in Section 8. It aimed at the assurance that only rice which had been inspected and placed in its proper category should be exported. It did not restrict anyone—the small man or the large interests—from trading so long as the product was graded and conformed to one of the fixed classes. It did not aim at restricting trade in any sense, but on the other hand it provided the fullest protection possible to cultivators, rice millers and exporters.

He would like at that juncture to refer to the work of the sub-committee of the Chamber of Commerce whose recommendations as to grading had been adopted for the purpose of the Bill. Some time ago, the Chamber of Commerce appointed a committee to consider all questions affecting the export of rice, and grading, of course, was the one thing that had the greatest attention paid to it. The committee was divided into two parts, one sub-committee dealing with matters affecting grading and the other dealing with more financial questions. The sub-committee went about its work by collecting from the trade and from millers a large number of rice samples which were subjected to a rigid and care-

ful analysis in the Department's laboratory from the point of view of the percentage of broken grains, colour and general quality, and as a result of the examination they were able to decide very definitely what grades should be recommended to be adopted in any legislation dealing with regulations for this purpose.

The Recommendations.

The recommendations were as follows:—

(1) That graded rice be exported under four classes:—

(a) "Whole grain super"—not to exceed more than a total of 5 per cent. of broken and discolourd grains.

(b) "Super"—not to exceed more than a total of 10 per cent. of broken and discoloured grains.

(c) "No. 1"—not to exceed more than a total of 25 per cent. of broken and discoloured grains.

(d) "No. 2"—not to exceed more than a total of 40 per cent. of broken and discoloured grains.

Any rice below these standards was to be ungraded, that was to say, the rice would still be examined but would not be classified in any special grade. They felt that they should not prohibit the exportation of any of the lower grades of rice that did not come within these classes, but that they should be stamped in the category of ungraded rice. As regards colour, there was some difficulty in arriving at a definite conclusion, but they had been able to settle satisfactorily that point. In the early stages the Department of Agriculture would have to provide samples showing the colour standards in respect of the different classes; but later on, they hoped with the help of Mr. Douglas and others to put the colour on much more scientific lines; they proposed to adopt something of the Dutch colour standard in respect of sugar by having a strip, which—beginning with white at one end and proceeding through the various stages with dark at the other end, each block in the strip being numbered—would be able indicate definitely what class of rice would fall in a particular section. As he had said, the object to be aimed at was to have this grading and colour on thoroughly scientific lines; that would take a little time to get working, but for a start they hoped to be able to make such samples of rice which all growers, millers and exporters would be able to see and use as guides. Sub-section 8 of Section 8 referred to the payment of certain fees to cover the cost of grading. The Government had decided that the rate should not exceed two cents per bag, and this, it was hoped, would cover all charges. It was not the intention to make any profit from this transaction and only a sum sufficient to cover all expenses would be recovered. Government could not face the expenditure for new services, and as this was a new service the charge was considered a fair one. The service, moreover, actually provided a trade inducement leading to improved market conditions and that would offset the small charge.

Appeals.

Section 10 provided for an appeal, from the decision of an Inspector, to the Director of Agriculture ; in the case of any points, technical in nature, to be settled, it followed that the appeal would have to be made to the Head of the Department in charge of the supervision of technical matters connected with the industry. At the same time, with the formation of a strong rice association, which was contemplated, there should be no fear that any powers under the Bill would be exercsied in an arbitrary manner. It would be felt by some that the Bill did not go far enough. Government, however, felt that they should not attempt too much at the beginning. In order, however, to ensure that a start be made as early as possible in one direction, viz., certificated grading, the absence of which was considered a most important obstacle at present, Government had introduced the Bill in its present form without further delay.

Tribute To East Indians.

Before he resumed his seat he would like to pay a tribute to the East Indian population who had done so much for the industry of the colony ; and to state further that in all the steps the Department had taken to improve the industry and place it on a firm foundation, the reception from those who were interested in it was all that could be desired. He hoped that that would continue so that before very long the rice industry would be of the first magnitude and would help them to pull the colony out of the rut in which it had found itself.

2. RICE (EXPORT GRADING) ORDINANCE (1930).

Be it enacted by the Governor of British Guiana, with the advice and consent of the Legislative Council thereof, as follows:—

Short Title. 1. This Ordinance may be cited as the Rice (Export Grading) Ordinance, 1930.

Interpretation of terms. 2. In this Ordinance, unless the context otherwise requires, the following expressions have the meanings hereby assigned to them—

"Rice" means milled rice;

"Inspector" means any person appointed under section four of this Ordinance;

"Ship" means any boat or vessel of any description.

Prohibition of export of rice without inspection. 3. No person shall export or attempt to export or cause or permit to be exported from the Colony any rice unless and until such rice has been inspected and graded by an Inspector in accordance with the regulations made under this Ordinance.

Appointment of Inspectors. 4. The Director of Agriculture may with the approval of the Governor-in-Council appoint such Inspectors as he may consider necessary for the purpose of examining and grading rice intended for export and for carrying out the provisions of this Ordinance.

Powers of entry. 5.—(1.) Every Inspector may at all reasonable times enter any premises or board any ship in which is kept or stored or suspected of being kept or stored for export any rice, and may examine any part of such premises or ship or any receptacle or package therein.

(2.) If any rice is found by an Inspector on any premises or in any ship which he has entered or boarded under sub-section one of this section, he may seize and detain the same if he is of opinion that such rice is intended for export without being graded.

Obstruction, resistance or hindrance of Inspector. 6.—(1.) Any person who obstructs, resists or hinders an Inspector in the lawful exercise of his powers or duties under this Ordinance or any regulations made thereunder, shall be guilty of an offence against this Ordinance.

(2.) Any person who alters or changes or attempts to alter or change the grading of any rice after such rice has been graded by an Inspector shall be guilty of an offence against this Ordinance.

Issue of false documents. 7. Any person who with intent to deceive issues a written warranty or invoice, label or certificate or notification in respect of rice

intended for export, shall, if such written document falsely describe such rice or is false in any other material particular be guilty of an offence against this Ordinance.

8. The Governor-in-Council may from time to time make regulations generally for carrying out the provisions of this Ordinance and may in particular by those regulations provide for ;— Regulations

(1.) The inspection of rice, the fixing of grades, the place and manner of inspection and of grading and marking of any rice and the manner in which different designations or grades of rice shall be marked or indicated, whether on the receptacle or on a certificate of the Inspector or otherwise ;

(2.) The time and place at which and the manner in which notice of intention to export shall be given, the manner of packing, description, quality and material of the content and the marking of such weight, and of the receptacles ;

(3.) The places and manner of storage ;

(4.) The percentage which shall be inspected in any one consignment ;

(5.) The abstraction or removal of samples by an Inspector for examination, inspection or analysis ;

(6.) The circumstances under which different kinds of rice may be accepted or rejected, regraded or re-marked by an Inspector after examination and inspection ;

(7.) The forms of notices, certificates and other documents and marks to be used or issued for the purposes of this Ordinance ;

(8.) The fees or dues which shall be paid by the owner or the consignor of rice for inspection and for grading ;

(9.) The duties and powers of Inspectors ;

9. Any person who is guilty of an offence against this Ordinance or who contravenes any provision of this Ordinance or of any regulation made thereunder, shall be liable on summary conviction, in the case of a first conviction, to a fine not exceeding one hundred dollars and in the case of a second or subsequent conviction to a fine not exceeding five hundred dollars, and in default of payment in either case to imprisonment not exceeding six months. Penalty.

10. If any person is aggrieved by any decision or of action taken, by any Inspector under this Ordinance, the Inspector shall, if required in writing within seven days, by such person, state in writing his Appeal.

reasons for his decision or action, and such person may within seven days of the receipt of such statement appeal in writing to the Director of Agriculture, and the Director or Deputy Director of Agriculture shall thereupon hear and determine the matter in dispute.

Commencement.

11. This Ordinance shall come into operation on such date as the Governor shall notify by proclamation in the *Gazette*.

3. REGULATIONS MADE IN PURSUANCE OF THE RICE (EXPORT GRADING) ORDINANCE, 1930.

1. These regulations may be cited as the Rice (Export Grading) Regulations, 1930. Short Title.

2. The grades of rice together with their class and description shall be as set out in the first schedule to these Regulations. Grades of rice. First Schedule.

3. Samples of rice according to the grades set out in the first schedule will be supplied on request by the Department of Agriculture on payment of one dollar. Guide samples.

4. Rice for export shall be delivered in a manner suitable for the purposes of inspection and grading at such of the wharves in Georgetown or New Amsterdam as the Director of Agriculture may specify by notice in the *Gazette*. Places of delivery for inspection and grading.

5. Rice will not be allowed to be exported in old, torn or disfigured bags, and all bags before export must be securely sewn with overlapping edges. Condition of bags for export.

6. The exporter of rice shall, prior to delivery in pursuance of regulation 4, grade his rice in accordance with the first schedule, and shall on or after delivery as aforesaid give to the Inspector three days prior to shipment notice of application to grade. Such notice shall be in the form set out in the second schedule* and shall be delivered to the Georgetown Inspector at Messrs. Smith Bros. & Co., Ltd., and to the New Amsterdam Inspector at the Agricultural Superintendent's Office, Queenstown. Rice to be graded and notice given by exporter. Second Schedule.

7. The Inspector shall examine a minimum of 25 per cent. of the bags of each consignment, but, if after or upon examination he is in any way dissatisfied, he may examine every bag of such consignment before he issues a certificate of grade. Particulars of examination.

8. For the purpose of examination it shall be lawful for the Inspector to abstract and remove a sample of not less than 10 lbs. of rice from each consignment, the sample to be returned to exporter on request within 12 hours after issuing of grading certificate. Abstraction of sample for examination.

9. After the rice has been examined and graded by the Inspector he shall issue a certificate of grade, according to the form set out in the third schedule.* Issue of certificate. Third Schedule.

[PRICE 8d. To be purchased from "The Argosy" Company, Ltd., Water Street, Georgetown, British Guiana, and from the Crown Agents for the Colonies, 4, Millbank, London, S.W.1]

*Not here reproduced.

Costs of grading and payment.

Fourth Schedule.

10. The consignor shall pay at the rate of two cents per bag in respect of all rice submitted for grading under these regulations according to particulars given in the fourth schedule* and payment therefore shall be made to the Customs at the same time that the export tax is collected.

Removal and regrading.

11. If rice which has been graded is removed from the place of delivery without being shipped and is later re-submitted for export it shall be again graded in accordance with the preceding regulations and the same fees shall be payable.

Period of validity of certificate before shipment.

12. A certificate, which has been issued in respect of graded rice, shall cease to have effect unless such consignment is shipped within fourteen days after the date of the issue of such certificate, unless renewed by the Inspector under the authority of the Director of Agriculture.

Weevily rice.

13. Rice which is found on examination to be weevil infested and likely to be a source of infestation to other rice consignments will not be allowed to be exported.

Removal of weevily rice.

14. If the Inspector should give notice in writing of the removal of rice which is found to be weevil infested such rice shall be removed from the places of delivery forthwith at the expense of the exporter.

Branding of bags.

15. Each bag of rice graded in accordance with these regulations shall be branded with the consignee's mark.

Hours of attendance

16. The working days for Inspectors or examiners are all days except Sundays and public holidays and the hours of attendance are:—

Mondays to Fridays	...	7 to 11 a.m. 12.30 to 4 p.m.
Saturdays	...	7 a.m. to 12 noon.

Additional fees Sundays and public holidays.

17.—(1) The following additional fees shall be paid by the consignor for the services of officers when required to attend on Sundays or public holidays or at times other than those prescribed as the hours of attendance :—

Rank of Officer.			For every Hour or Part Thereof.
Inspector	...	...	$ 1 44
Senior examiners	...	...	96
All other examiners	...	...	24

(2.) All fees shall be paid to revenue, and these shall be collected by the Inspector at the time of issue of the certificate.

* Not here reproduced.

FIRST SCHEDULE.

RICE.

Class.	Description.	Colour.
Whole grain super .	Not to exceed more than a total of 5 per cent. of broken and discoloured grains.	As per guide sample.
Super ..	Not to exceed more than a total of 10 per cent. of broken and discoloured grains.	do.
No. 1 .	Not to exceed more than a total or 25 per cent. of broken and discoloured grains.	do.
No. 2 .	Not to exceed more than a total of 40 per cent. of broken and discoloured grains.	do
Super broken grain	Same standard as whole grain super or super as regards colour.	do.
White Rice	To be dry, reasonably clean, white and to contain not more than 5 per cent. of discoloured grains (Grains may be of irregular size and broken).	do.
Ungraded	All rice below the above standards.	

NOTES.

Rice Grass.—*Spartina spp.* Considerable attention has recently been paid in England and other parts of Europe to a maritime grass, *Spartina Townsendii*, known as 'Cord' or 'Rice Grass,' which has shown remarkable powers of spreading upon mud banks and salt marshes.

The grass was first recorded at Southampton, on the South Coast of England. One theory as to its origin was that it had been introduced by a ship from the River Plate coming up Southampton water with a quantity of the grass on board. It is also suggested that it arose as a hybrid between two other species of the same genus (*S. alternifolia* and *S. stricta*).

Though its origin must remain uncertain for the present, there is no doubt as to the rapidity of its spread along the shores of the English Channel, (for it is found upon the French Coast also). Recently, its mud binding properties having proved so remarkable, the grass has been planted artificially on parts of the South-East Coast of England, and also on the Coast of Holland, to help form a natural protection against the inroads of the sea.

In addition to its powers of colonisation upon the sea-shore, this grass has proved to be of no little value as a stock feed, and, when growing on the coast, is eagerly grazed by animals from the neighbourhood.

The interest to this colony in *Spartina Townsendii* lies in the fact that another species of Spartina, *S. brasiliense*, grows locally upon the muddy foreshore and in such like habitats, where it is also known as 'Rice Grass.'

Some years ago, when the sea was encroaching upon the colony's coast, and in particular upon the East Coast, Demerara, attempts were made to encourage the growth of various plants on the soft mud outside the sea wall, in order to protect the latter. The growth of 'Courida' and 'Mangrove' was encouraged, together with other plants, amongst them, 'Rice Grass,' which was planted out at a number of points along the coast.

In more recent years, the action of the sea has changed, and where erosion formerly took place, silting now occurs, the consequence being that the old sea dam, for the greater part of its length from Kitty to Enmore and beyond, is now some hundreds of yards from the present shore line, the intervening land being covered with the typical foreshore vegetation.

It is of interest to note, however, that the 'Rice Grass,' once unknown on this part of the coast, has now established itself in many areas. It thrives upon the soft mud, though not found where this is admixed with sand and of a

firmer texture. Opposite Bel Air, for instance, the foreshore is covered with this grass, intermingled with small patches of 'Crab Grass,' *Sporobolus virginicus*.

There seems no doubt then as to the mud binding qualities of the local species, but its possible properties as a stock feed are more a matter for speculation.

Cattle are not usually found upon the foreshore, but sheep and goats seen outside the sea wall appeared to be feeding upon 'Crab Grass' and other plants, rather than the Spartina. An attempt is to be made by the Department, however, to establish the European species locally, in the hope that it may prove of value here as it has elsewhere.

Some plants of *Spartina Towsendii* were received by this Department from England in August, and have been planted out on the foreshore between Kitty and Liliendaal. Three sites were selected, one upon a rather sandy area, and two on the mud, one of which is only covered at spring tides, the other by every tide. In these two latter habitats the grass appears to be establishing itself, especially where it is covered daily. On the more sandy part of the shore, however, the plants do not seem likely to survive.

E. B. M.

Tung Oil.—The Empire Marketing Board issued, in June, a Memorandum (E.M.B. 31), prepared by the Imperial Institute, on the production of Tung Oil in the Empire. Tung Oil is an essential raw material of present-day varnish manufacture, and its properties as a drying oil render it indispensable for certain types of varnish in which tough water-resistant films of high gloss are desired. The oil is now widely used as an ingredient of certain types of paint media, in the manufacture of electrical insulating varnishes and in the linoleum industry.

To-day, this oil is one of the chief exports of China, and the price is maintained at a high level because all countries are dependent on China for supplies which are often of inferior quality, and sometimes adulterated. In view of the importance of this material to the paint and varnish industry, there has been a strong feeling that the industry ought not to continue as China's monopoly. Plantations have already been started in the United States of America and are developing rapidly. The purpose of the memorandum is to present a summary of available information upon the cultivation of Tung trees and the winning of the oil from the seed so that a proper judgment may be made as to the feasibility of supplying British needs for Tung Oil by the cultivation of the trees within the Empire.

Tung Oil is obtained from the seeds of *Aleurites Fordii* Hemsl. Another species, *A. montana*, yields Mu-yu oil and these two oils are indiscriminately mixed and exported from China as "Chinese Wood Oil." It appears that *A. Fordii* thrives best in climates which are less tropical than those which favour *A. montana* which requires a heavier hot-weather rainfall.

An historical survey is made of the cultivation of Tung trees in the Empire, and it may be noted that in 1911 seed of *A. Fordii* was despatched from Kew to the Imperial Commissioner of Agriculture for the West Indies, but the experiments carried out were not successful. So far as the British Empire is concerned, although there are records of individual trees that have reached the fruiting stage, it is not yet possible to select, with assurance, particular districts for the establishment of plantations of either species. It is recommended that initial experiments with both species be made in areas in which the climate appears most suitable. At the present time, the only experience of Tung Oil plantations is that gained in Florida, and to a limited extent in New South Wales. Experience in the United States and Australia is, however, confined to the species of *A. Fordii* as *A. montana* seems to require a more tropical climate.

Yield figures from plantations in the United States indicate that at the end of six years the yield of dry fruit per acre is approximately 1,300 lbs., equivalent to 280 lbs. of oil.

The nuts are composed of about 43 per cent. of shell and 57 per cent. of kernel which has an oil content of about 56 per cent. The oil can be expressed in oil-crushers similar to those used for other oil-seeds. £69. 10s. per ton was the price quoted in London, in January, 1930. The oil cake left after the expression of the oil contains nitrogen, phosporic acid and potash, and is used as a fertiliser. It is not known if the cake can be used as a feeding stuff.

It is considered that there will be a constant demand for Tung Oil as it is a raw material which is essential in some industries, and that, with an increased supply, new uses will be found for the oil.

The production of Tung Oil in the Empire is now considered of such importance that a special sub-committee was appointed by the Imperial Institute Advisory Committee on oils and oil-seeds to make investigations. This Sub-Committee, besides being engaged in encouraging the cultivation of Tung trees within the Empire by the distribution of seed and the dissemination of information relating thereto, is carrying out investigations which it is hoped will be beneficial to the industry.

It may be of interest to mention that seeds of *A. Fordii* have been recently obtained by this Department, and the seedlings are being planted at the Hosororo Station, North West District. Seedlings of *montana* are expected shortly, and, on the arrival of these, it is intended to carry out comparative tests between the two varieties.

H. D. H.

DEPARTMENTAL NEWS.

His Excellency the Governor, Sir Edward Brandis Denham, K.B.E., C.M.G., arrived in the Colony on Monday, June 9, and visited the Head Office (Department of Agriculture), the Cane Experiment Station, the Rice Experiment Station, and the Botanic Gardens on Wednesday, July 2. A visit was paid to the Stock Farm on Monday, September 15.

His Excellency visited Anna Regina, the Land Settlement at Bush Lot and the seed paddy station at Henrietta on July 30, and various rice mills in the Essequibo District on August 1, and 2.

On July 1, His Excellency called a meeting of the rice planters, millers and exporters with a view to discussing the ways and means of stabilizing the rice industry of the Colony. His Excellency emphasised the necessity for introducing legislation to enforce the grading of rice for export in accordance with the recommendations submitted by the sub-committee under the chairmanship of the Director of Agriculture.

During the period under review the Director toured the East Coast of Demerara (Triumph, Betervewagting and Buxton), accompanied His Excellency the Governor on an inspection tour of the Pomeroon and Essequibo districts, and visited Pln. La Bonne Intention.

The Deputy Director of Agriculture visited the Essequibo Coast on several occasions with special reference to the Bush Lot Land Settlement Scheme. Circuits of inspection in connection with the sugar-cane and rice experiments were also made in the following districts.—Corentyne, Canje District, West Coast Berbice, East and West Coasts, Demerara. Special visits have been made, in company with the Entomological Assistant, to Letter T and other coconut estates in connection with the control of outbreaks of the Coconut Caterpillar (*Brassolis sophorae*) and the Large Locust (*Tropidacris latreillei* Perty.)

Mr. L. M. Nightingale who had been seconded for duty as Settlement Officer, Essequibo, has been transferred to Georgetown as Atg. Chairman, Local Government Board. In consequence, Mr. A. deK. Frampton, Agricultural Superintendent, Essequibo, has been appointed Settlement Officer in addition to his regular duties. Mr. A. A. Abraham, Assistant Superintendent, Botanic Gardens, has been transferred to Essequibo as Assistant Agricultural Superintendent. Mr. E. B. Martyn, Botanist and Mycologist, has assumed control of the Botanic Gardens, to which Mr. H. A. Cole has also been transferred, as Horticultural Assistant, from Essequibo.

His Excellency the Governor has been pleased to depute Mr. L. D. Cleare, Entomologist to this Department, to represent the Colony at the Third Imperial Entomological Conference opened in London on June 17.

Mr. E. M. Morgan, Senior Agricultural Instructor, resumed duties on June 30, after 6 months' leave of absence in Barbados, and is now stationed at Rose Hall, Corentyne.

Miss J. Pestano, record clerk of the Department, left the Colony for Canada on June 30, on 6 months' leave of absence. Miss M. Smith has been drafted into the Department to act during Miss Pestano's absence.

Mr. E. G. A. Benson, B.Sc. (Agric.), (Lond.), Dip. Agric. (Wye)., has been appointed Grading Inspector in connection with the Rice (Export Grading) Ordinance, and Mr. A. W. Sears, ex-agricultural apprentice, has been promoted to the post of Senior Examiner.

The following are also Inspectors for the purposes of the Ordinance :— the Deputy Director and the District Agricultural Superintendents of East Demerara, West Demerara, Berbice and Essequibo.

A conference of Staff Officers was held at the Head Office on Thursday, September 11. The Director gave a pronouncement on various important phases of departmental policy, and there followed informal discussions on subjects which were of particular interest.

The possibility of exploiting some of the Colony's fibre producing plants has been attracting attention. Recently, Capt. the Hon. M. Parker and Messrs. J. B. Llewellyn and R. T. Keith from London visited the Colony to investigate local conditions. Accompanied by the Government Botanist, the party went to Christianburg, in which neighbourhood the Crowa fibre plant is to be found. Subsequent visits were made by Mr. Keith to other localities including a trip to the North West District, where he was the guest of Mr. A. W. Long, the Commissioner.

Mr. J. C. Nagel, representing the Palm Oil Company of New York, which firm manufactures crushing machinery for the extraction of oil from palm fruits etc., recently visited the Colony. He discussed with the Director and the Government Botanist, the possibilities of the indigenous palms for oil producing purposes and appeared specially interested in the Kokerite (*Maximiliana regia*,) owing to its prevalence in many areas. Mr. Nagel visited the Canje District in order to personally observe the conditions under which this palm grew.

A sale of animals at the Government Stock Farm took place on Saturday, August 30. The following Holstein-Freisian bulls and calves were sold for breeding purposes :—

"Texas Bob" — to Mr. E. McTurk, Rupununi.
"Texas Bud" — to Mr. A. M. Fulton, Consulting Veterinary Surgeon.
"Bruce" — to Mr. G. Eccles for Bath Estate, Berbice.
"John" — to Mr. J. H. Haly, Corentyne.

The Department's Stock Farm has recently imported two Holstein-Freisian heifers, "Jemima Elizabeth Kerk" and "Cobequia Mercena Kerk" from the Maritime Holstein Association, Canada.

The poultry have also been increased as follows :—

(a) 6 Rhode Island Red pullets from over 220 eggs stock and 1 Rhode Island Red Cockerel individually bred from hen laying 257 eggs, imported from Claydon Farm, Gloucester, England ;

(b) 6 White Leghorn pullets and one white Leghorn Cockerel imported from Raikes Hall Farm, Yorkshire, England.

Progress continues to be made in Land Settlement activities at Bush Lot, Essequibo, where the planting of the Autumn rice crop has been completed by the settlers. The growth to date has been satisfactory, and a good return is expected. Settlers are now devoting their attention to the cultivation of kitchen-garden and provision crops.

At an Exhibition held, September 8-10, by the British Guiana Workers' League, the Department erected a special booth and displayed exhibits bearing on the important phases of all the major agricultural industries. There could be seen in the Department's stand :—new varieties of cane that are showing promise, diagrammatic representations of the methods employed in carrying out manurial and varietal experiments, the rice grading machine and complete collections of the guide samples specified in the Rice Grading Regulations, large sized photographs, as well as living and dead specimens, of the important insect pests, simply worded descriptions of the advised means of control of the serious pests and diseases, and selected animals and poultry from the Department's Stock Farm, etc. During the Exhibition, officers were on duty at the Department's stand, and endeavoured to explain all matters likely to be instructive and of interest to visitors.

The Empire Marketing Board has been pleased to make a grant of $960.00 per annum to the Department, which sum is to be expended, firstly, in getting together a representative living collection of indigenous plants possessing insecticidal properties; secondly, in making extended cultivation trials with Black and White Haiari (*Lonchocarpus* sp. or spp.) and with *Tephrosia toxicaria*. These trials have already been inaugurated at the North West Experiment Station.

"The Report on the cultivation, treatment and prospects of rice in British Guiana" by Mr. C. E. Douglas, M. I. Mech. E., A. M. I. Pet. T., M. I. Struct. E., issued by the Empire Marketing Board (E. M. B. 32.) has been received as this Journal goes to print and cannot therefore be reviewed in this number. The Report is being printed in the daily press, and local farmers, millers and other persons interested in the rice industry will have every facility for studying the Report.

PLANT AND SEED IMPORTATIONS.

THE FOLLOWING ARE RECENT INTRODUCTIONS BY THE DEPARTMENT OF AGRICULTURE.

DESCRIPTION	QUANTITY	WHENCE RECEIVED
Economic.		
Pigeon Pea Seeds—"Cubanos"	1 packet seeds	Department of Agriculture, Trinidad.
"Manchadoz"	" " "	
"Negros"	" " "	do.
"Horacios"	" " "	do.
"Mites"	" " "	do.
"Americanos"	" " "	do.
"Silvios"	" " "	do.
"New Era"	" " "	do.
"Cadios"	" " "	do.
"San Salvador"	" " "	do.
"Aocibenos 4447"	" " "	do.
"Aocibenos 4448"	" " "	do.
"Larenos 4446"	" " "	do.
"Dominica 813"	" " "	do.
Tung Oil—A. Fordii	" " "	Bureau of Plant Industry. U.S.A.
" " "	60 seeds	Royal Botanic Gardens, Kew, Surrey, Eng.
Egyptian Clover	1 packet seeds	Ministry of Agri., Egypt.
Duncan Grapefruit	100 buds	Dept. of Agri., Trinidad.
Marsh "	500 "	do.
Parson Brown Orange	150 "	do.
Dancy Tangerine	150 "	do.
Valencia Orange	150 "	do.
Navel Orange	150 "	do.
Pita (Bromelia magdalenae)	12 plants	Imperial College of Tropical Agriculture, St. Augustine, Trin.
Elæis guineensis	7 lbs.	Dept. of Agri., Nigeria.
Onion	35 lbs. seeds	Teneriffe.
Ornamental.		
Gliricidia maculata	2 lbs. seeds	Dept. of Agri., Trinidad.
Calyptrocalyx spicatus	1 tin seeds	Botanic Gardens, Singapore.
Strelitzia reginæ	1 plant	Richmond Nurseries, Eng.

EXPORTS OF AGRICULTURAL AND FOREST PRODUCTS.

Below will be found a list of the Agricultural and Forest Products of the Colony exported during the first six months of 1930.

The corresponding figures for the same period during previous years and the average for the twelve years prior to that are added for convenience of comparison.

Product		*Average 1916-27*	*1928*	*1929*	*1930*
Sugar	tons	41,070	55,696	41,041	54,474
Rum	proof gallons	1,181,590	891,795	616,189	508,412
Molasses	gallons	226,840	1,382,186	1,760,043	2,242,960
Molascuit	tons	616	981	641	353
Rice	tons	4,556	8,925	7,264	11,147
Coconuts	thousands	1,070	118	252	220,825
Coconut Oil	gallons	12,280	13,404	9,388	9,738
Copra	cwts.	5,374	27,154	44,137	28,400
Coffee	cwts.	3,505	6,013	7,422	1,004
Lime Juice Concentrated	gallons	3,424	4,266	5,861	4,614
Essential Oil of Limes	gallons	98	306	367	369
Rubber	cwts.	54	123	None	46
Balata	cwts.	3,207	2,177	1,425	1,981
Gums	lbs.	1,217	1,008	None	787
Firewood—Wallaba, etc.	tons	4,125	5,841	5,196	5,913
Charcoal	bags	21,657	22,561	28,141	26,674
Railway sleepers	No.	8,030	4,393	7,701	3,369
Shingles	Thousands	1,002	938	1,240	847,550
Lumber	ft.	88,683	90,023	73,464	67,634
Timber	cu. ft.	79,062	67,277	143,889	89,553
Cattle	Head	194	87	146	1,089
Hides	No.	3,106	3,919	3,237	3,195
Pigs	No.	215	179	166	516
Sheep	No.	20	None	None	None

CURRENT PRICES OF COLONIAL PRODUCE.

From The Commercial Review, Journal of the Georgetown Chamber of Commerce, Vol. XIV, No. 2, August, 1930.

SUGAR.

Per 100 lbs. net   3 lbs. per Bag allowed for tare

Dark Crystals for Local Consumption..................$2.80
Yellow Crystals do. do. $3.50
White Crystals...$
Molasses Sugar...... ....none offering

RUM.

Imperial Gallon.   Cask included.

Coloured, in Puncheons—40 to 42 O.P...(for export).....60c. Hhds. 65c. Barrels 70c.
White, in Hogsheads—10 to 45 O.P....(for local consumption)...........48 to 55c.

MOLASSES.

Per Imperial Gallon.   Cask included.

Yellow (firsts).. }
Yellow (seconds)... } None Offering
Dark.. }

RICE.

Rice............per Bag of 180 lbs. gross, $3.80 to $5.00 as to quality.
Paddy..........per Bag of 143 lbs. gross, $1.32 to $1.50

GENERAL.

Timber, Gr. Heart, (Lower grade measurements)...72c. to 96c. per c. ft., for export $1.00 to $1.20 per c. ft.
Do. Railroad Sleepers—(Mora)..$1.68 each
Greenheart Lumber...$110 per 1,000 feet
Crabwood Lumber...$60 to $75 per 1,000 feet
Shingles, Wallaba, 4 x 20 and 5 x 22 inches,......................$7.00 to $9.00 per M
Charcoal, Capped for shipment ....$1.00 to $1.20 per Bag
Firewood..$3.00 to $3.50 per ton
Coconuts.........Selects, $18.00, culls......$10.00 M.................Copra, 3¼c. per lb.
Balata..............................Venezuelan, none. Local Sheet...38 to 40 cts. per lb.
Cocoa..14c. „ „
Coffee..7c. „ „

N.B.—Duty payable on value at time of Importation and at Rate of Exchange on day of arrival.

METEOROLOGICAL DATA—APRIL—JUNE, 1930.

Recording Stations & Months.	Rainfall. Total Inches.	Number of Days of Rain: Under ·10 Inch	·10 to ·50 Inch	·50 to 1.00 Inch	1.00 Inch to 2.00 Inches	Above 2.00 Inches	Total days.	Evaporation. Inches	Air Temp. Maximum.	Minimum.	Mean	Humidity. Mean
Botanic Gardens.												
April ...	9·60	5	9	3	2	1	20	5·62	84·6	75·9	80·2	80·6
May ..	12·94	6	12	3	1	2	24	4·07	84·1	75·9	80·0	84·7
June ...	12 62	7	11	7	2	1	28	2·87	84·1	75·1	79·6	85·1
Totals	35·16	18	32	13	5	4	72	12·56				
Means.	...	...	...	...	...	...	...	...	84·3	75·6	79·9	83·5
Berbice Gardens.												
April ...	9·56	10	6	5	3	...	24	...	86·9	75·0	80·9	76·8
May ..	10 43	6	12	5	1	1	25	...	86·7	75·5	81·1	82·3
June ...	13·41	8	8	9	1	1	27	...	86·5	74·6	80·5	83·5
Totals	33·40	24	26	19	5	2	76	...				
Means.	...	...	..	...	...	...	...	...	86·7	75·0	80·8	80·9
Onderneeming.												
April ..	5·22	1	10	...	2	...	13	...	87·3	74·8	81·0	82·2
May ..	17·93	...	5	7	6	1	19	...	86·7	73·9	80·3	83·4
June ...	13 51	2	10	7	1	2	22	...	86·8	74·5	80 6	82 3
Totals	36 66	3	25	14	9	3	54	...				
Means.	...	...	...	...	...	...	...	...	86·9	74·4	80·6	82·6
Morawhanna, N.W.D.												
April ...	6·46	1	10	4	1	...	16	...	...	...	...	...
May ...	8·17	5	11	4	2	...	22	...	...	...	...	...
June ...	10·39	...	18	6	2	...	26	...	...	...	...	...
Totals	25·02	6	39	14	5	...	64	...	...	...	..	...

Vol. III No. 4. December, 1930.

The Agricultural Journal of British Guiana

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BRITISH GUIANA.

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SUGAR EXPERIMENT STATIONS.

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„ C. Farrar	New Amsterdam	
„ A. Murison	Pln. Uitvlugt, W. C.	
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STAFF.

Agronomist	C. H. B. Williams, D.I.C.T.A.
Field Manager	C. Cameron
Laboratory Assistant	L. A. Robinson
Field Assistant	L. A. Forte
Clerical Assistant	J. B. Bourne

In oollaboration with the Officers of the Department of Agriculture.

CONTENTS.

(Vol. III, No. 4.)

DIVISIONAL ANNUAL REPORTS.

1929.

LIST OF ILLUSTRATIONS.

PREFATORY NOTE.

In this number of the *Agricultural Journal* there are published the reports of Divisional Officers for the year ending December 31, 1929. This was the method adopted last year of presenting these detailed reports, the general summaries of the more important activities undertaken being given in the Director's Administration Report for 1929 published earlier in the year.

The funds available do not permit of these Reports being published in any other form at present and, for convenience, they are placed at the end of the Volume and not in one of the earlier issues of the year.

J. SYDNEY DASH,
Director of Agriculture.

December, 16, 1930.

The

Agricultural Journal of British Guiana.

December, 1930.

DEPARTMENT OF AGRICULTURE DIVISIONAL ANNUAL REPORTS.

SUGAR EXPERIMENT STATIONS.

ANNUAL REPORT, 1929.

INTRODUCTION.

The last complete annual report issued by the British Guiana Sugar Planters' Experiment Station covered the year ending September 30, 1926. Since that date a considerable number of changes have taken place resulting in a re-organisation of the Station's staff and experimental programme, under the control and guidance of the Director of Agriculture and with the fullest co-operation of all members of the Staff of the Department of Agriculture.

On January 25, 1929, the Sugar Experiment Stations' Ordinance, 1929, became law. The Ordinance has been published in *The Agr. Jour. of B.G.*, II, pp. 46-49. It provides for the appointment of a Committee by the British Guiana Sugar Planters' Association (the Director of Agriculture to be, *ex officio*, Chairman of the Committee) for the establishment, general direction, care and control of the Sugar Experiment Stations, and for the collection of a cess of twenty-five cents per acre from every acre of land cultivated to sugar, provided the cultivator of any particular portion have more than twenty five acres under cane ; the funds thus secured being used almost entirely for cane breeding and field experiments.

The writer only assumed duties on May 14, 1929, but an effort is made, as far as records will allow, to report briefly on the activities of the Stations for the entire period, October 1, 1926, to December 31, 1929.

Committees.

The Sugar Experiment Stations' Committee comprised in January 1929 :—

The Director of Agriculture			Chairman, *ex officio.*
Mr. R. Strang			Pln. Uitvlugt
„ G. E. Anderson	...	...	„ Diamond
„ A. E. Craig	...	...	„ Ogle
„ J. C. Gibson	...	...	„ Port Mourant
„ C. Farrar	...	...	New Amsterdam
Hon. R. E. Brassington			Georgetown.

The same members were functioning at the end of the year except that Mr. Strang, whose lamented death was chronicled in *The Agr. Jour. of B.G.*, II, p. 212, was replaced by Mr. A. Murison, Manager of Plantation Uitvlugt.

STAFF.

Dr. C. L. Whittles, Superintendent, was granted leave of absence from June 1, 1927. He returned to the Colony on November 15, but was forced by ill health to tender his resignation as from December 31, 1927. Mr. E. M. Peterkin acted during Dr. Whittles' absence on leave.

Mr. A. D. E. Lauchlan, Chemist, was on leave for one month from March 17, 1927. His services were dispensed with at the expiration of his contract on December 31, 1927.

Mr. H. D. Huggins, Assistant Field Manager, was granted leave from March 17, to June 4, 1927. He tendered his resignation on January 31, 1928, to accept the post of Assistant Superintendent of Agriculture, Demerara County.

Mr. E. S. A. Chin, Laboratory Assistant, resigned at the end of September, 1927, to follow a course of training at the Imperial College of Tropical Agriculture.

Mr. C. Cameron, Field Manager, was on leave from April 1 to June 30, 1927.

Mr. L. A. Robinson, late Student of Queen's College, was appointed Laboratory Assistant on January 1, 1929. He was granted sick leave from August 1 to September 20.

Mr. C. Holman B. Williams, formerly Director of the Sugar Planters' Experiment Station, Guadeloupe, was appointed Cane Agronomist on the Staff of the Department of Agriculture, and assumed his duties on May 14, 1929.

Mr. L. A. Forte, late Student of Queen's College, assumed duties as Field Assistant on May 23, 1929.

During the transition period, the Field Manager, Mr. Cameron, carried on the field work practically alone, the work consisting mainly of the production and propagation of the 1927 and 1928 seedlings, small extensions of the more promis-

ing canes, cleaning and maintenance. Much credit must be given to him for the present condition of the Station and for preserving, at no little pains, a large number of seedlings, among which are some of very great promise.

Mr. C. L. C. Bourne has continued to fill the post of Secretary to the Experiment Stations' Committee.

EQUIPMENT.

In the past, two series of wooden rafters on which sheets of galvanised iron (zinc sheets) were placed during heavy rains or very hot sun, served as nurseries for the young seedlings. This arrangement offered several disadvantages, among which were the lowness of the rafters (causing one to stoop all the time), the lowness of the frames on which the seedling boxes were kept (this favoured attacks from grass caterpillars), and the constant shifting of the temporary roofing. One of these nurseries has now been rebuilt. It is provided with a concrete floor; the rafters are sufficiently high to permit workers to progress without bending, and the roofing consists of a series of jalousie-like flaps which can be easily closed or opened by a boy from inside, thus allowing sunlight or excluding rain at will. Thanks are extended to the Entomologist for the valuable suggestion on which this last arrangement is based. The second nursery will be reconstructed during 1930.

A new building of bamboo reinforced concrete, 36 feet by 20 feet, was constructed for housing the two experimental mills and their driving engine, the plans being drawn and executed by the Field Manager. This Mill House was opened by the then Governor, Sir Gordon Guggisburg, on January 28, 1929. An account of the proceedings and the addresses delivered on that occasion will be found in *The Agr. Jour. of B.G.*, II, pp 40-45. The mills were formerly housed in the compound of the East Demerara Experiment Station, Botanic Gardens. Their removal to Sophia is a great convenience as it centralises the work and obviates having to transport the cane samples any distance.

A concrete path 3 ft. wide has been recently put down from the point where a proposed bridge will span the Lamaha canal to the new nursery house which is to the East of the compound. This will greatly facilitate workers and visitors in wet weather.

A new driving road from the end of the main avenue of the Botanic Gardens to a point 200 yards to the North, opposite the building compound, enables Staff and visitors to gain easy access to the Station. A bridge to be erected across the Lamaha will complete this project. A shed has been erected at the end of the roadway just referred to. This serves to shelter the cars, cycles, etc., of the staff.

All boats have been overhauled during the year.

Bridges have been maintained, minor repairs effected to buildings, and the Office and Laboratory have been painted externally and internally.

The store room has been added to and painted during the year.

A fresh-water vat has been erected. Connected with the vat is a pressure tank into which water is pumped for supplying the juice analysis laboratory which is now at the Station compound instead of a distance away in the Botanic Gardens.

Apparatus other than that required for the juice analyses has been transferred to the Chemical Division of the Department of Agriculture, which has assumed responsibility for all work relating to agricultural chemistry.

Cane Breeding and Introduction.

The varieties under cultivation at the Station may be roughly divided into three groups, viz :—

(a) Varieties preserved for breeding work ;

(b) Older varieties produced prior to 1925 and introduced canes which have come to us with a reputation ;

(c) Newer varieties produced in 1925, 1927, 1928 and 1929.

With regard to the first group, it will suffice to say that many canes, in themselves poor commercial yielders, are of great use and interest to the plant breeder because of their power of transmitting certain characteristics to their progeny.

In the small experimental plots reaped in fields 2, 3, 5, 7, 8 and 10, during 1929, numerous varieties showed themselves to be equal or superior to D. 625. A careful comparison of the figures obtained with those accumulated in the Station archives, combined with field observations at Sophia and on estates, have enabled a list of 150 older and introduced varieties to be made. In this list are included all the canes which it is deemed advisable to test further both at Sophia and on the estates. Many hundred which were definitely inferior have been abandoned. With a few exceptions, all the varieties selected were only represented at the Station by a row or two across a single bed (36 feet). Effort is now being made to multiply all these canes as rapidly as possible. These varieties all fall under group *b*.

The canes in group *c* fall into sub-groups according to the year of their creation. Extensive selection work has been carried out on all. This has greatly reduced their numbers. Thus of the 1,523 seedlings created in 1925 we now only have 26 ; of the 5,313 created in 1927 we now only have 60, while of 1928's 7,878 there are now only 149 under observation.

During the breeding season of 1929, preliminary experiments were carried out with an apparatus designed to ensure the exclusion of foreign pollen from arrows it is desired to self. The results obtained so far are very encouraging,

and with the aid of this apparatus we have now a selfed family of S.C.12 (4). Unfortunately, owing to the depredations of thieves, who destroyed several selfed arrows which had been under observation, it was impossible to accumulate as much data as was expected.

On four nights continuous observations were made of the inflorescences of several varieties. With the other duties in hand at the time and the small staff it was not possible to do more of this tedious work. On some nights the florets began to open as early as 11 p.m., whereas on other nights opening commenced as late as 2 a.m. Evelyn's observation that florets of B.H. 10 (12) do not open for about one week after the first appearance of the fluff was confirmed. The florets of S.C.12 (4) appear to open almost as soon as the tassel begins to protrude from the sheath. Apparently under local conditions pollen is usually plentiful from 5 a.m. onwards.

Arrows of P.O.J. 2725 were "open crossed" with S.C.12 (4) of which arrows were cut and tied around those of the P.O.J. 2725 every afternoon, the stalks of the former being dipped in water in bottles to keep them fresh until they were replaced next afternoon. From arrows thus treated 34 seedlings have been potted out. In addition 20 seedlings were grown from P.O.J. 2725 arrows, with which no effort was made to control the male parent. Since, however, P.O.J. 2725 is usually self sterile, it can be assumed that all these seedlings are crossed between the Javanese cane, containing 12.5 per cent. "wild cane" in its constitution, and some of our best noble canes. If some of the crosses combine the best characteristics of their parents, they will be of great utility.

Sowings were made in 1929 from over 20 different mother canes or crosses, and over 6,000 seedlings have been basketted.

Mention has already been made (*The Agr. Jour. of B.G.*, II, pp. 194-198) of the varieties introduced from abroad last year; they comprise P.O.J. 2725, P.O.J. 2878, B. 6835, I.C.T.A. 36, I.C.T.A. 222, G. 115, G. 119, G. 140, G. 153, and G. 312. The Station is indebted to Mr. G. E. Anderson of Diamond for some cuttings of his very promising variety, Diamond 10, to Mr. A. Waterfield of Blairmont for cuttings of D. 663/13 and to Mr. F. F. Ross for cuttings of D. 651 from Skeldon.

During the period under review, 1,875 bags of tops were distributed locally and a few dozen tops and some arrow fluff sent abroad to kindred institutions.

In the next section of this report a dozen or more canes are mentioned as being especially worthy of the attention of planters. One or two of these are to be found in small quantities on practically every estate. A reference to the estate books will show where these are to be found in the plots and nurseries established with tops from the Station. It is advisable that each estate use every effort to multiply the ones it has as rapidly as possible.

In this connection it should be clearly understood by planters that it is most undesirable that any variety sent out by the Station be allowed to reach maturity and be milled before the estate has at least 20 acres of it. In the future comparatively few varieties will be given to the estates, and managers may be assured that when they do receive a variety there is good reason for believing it will be superior to the standard cane. It is not claimed that some such canes will not be turned down in the long run for some reason it is impossible to determine clearly in the experimental plots, but there will be sufficient time to do this discarding after the estate has the area suggested. On the other hand, to condemn a variety because the first plants (packed and forwarded over considerable distances by carts, boat and train) do not grow well in a new district, or to allow the canes to reach maturity and only plant the tops is to court delay and hinder progress. Nurseries should be cut and planted at about nine months. At this stage, almost all the buds (eyes) will be viable and the cane will yield four plants instead of one. If the plants are soaked for 24 hours in a saturated lime solution containing 1 lb. of epsom salts (magnesium sulphate) to 50 gallons, and planted immediately after in seasonable weather, the germination will be satisfactory. This process of drawing down and planting should be continued without interruption on both plant and ratoon nurseries until a few *pure* fields are established in different sections of the plantation. Then, and then only, should some of the fields be allowed to reach maturity and data be obtained as to yields, etc.

EXPERIMENTATION.

From its inception to the present time, the Cane Breeding work of the Station has received great attention. Work of this nature is slow in yielding results, for Nature cannot be hurried, but if we may judge from preliminary trials at Sophia during the past four or five years, from observations made in the field and from reports received from certain estates, the labour has not been in vain. There is good reason to believe that in 835/18, 666/18, 663/13, 683/13, 689/13, 73/20, 351/20, 557/20, 814/13, 699/20, 636/21, 684/21, B.H.10 (12), and S.C.12 (4), planters now have canes which will in some instances replace the D. 625 with great advantage, in others be worthy substitutes if and when D. 625 may have to be abandoned, in still others, suit some special soil or other conditions where D. 625 does not thrive.

But the definite evaluation of any or all of these varieties depends on the execution of a series of carefully planned variety trials in the various districts and extending over at least two complete cycles of plants and ratoons, for the final place of a particular variety depends, for any soil and climate area, on a very large number of factors.

There seems no doubt but that the search for a new variety in the past has been greatly hampered by the insistence of planters for tops of little known canes which have sprung into prominence as a result of one or two preliminary

trials, the distribution by the Station of small parcels of a very large number of imperfectly tested seedlings, and neglect of prolonged systematic testing by approved methods. Very often these canes have been lost. In some instances they have been lost on the Station and preserved on the estates, in most, preserved by the Station and lost on the estates.

Methods are now available for laying down tests and interpreting data which enable the professional experimenter to answer a given question with a very high degree of precision, and the policy in future will be first to experiment thoroughly at the Station and on the estates, and then to recommend and distribute material.

The planting and reaping of a variety trial field containing numerous separate plots require a large amount of planting material (an important factor when dealing with seedlings with which one starts with a single clump, or newly imported canes where for quarantine reasons only a few cuttings are introduced) and much time and supervision. It is therefore obvious that it is neither possible nor desirable to carry out experiments on all the estates of the colony, and it has been decided to make a start at five sub-stations situated respectively at Uitvlugt, Diamond, Lusignan, Blairmont, and Port Mourant.

Such experiments will :—

1. Relieve congestion at Sophia where neither space, labour nor funds would permit of such a large number of experiments being executed ;

2. Enable various ideas to be tried out under varying conditions of soil and climate as it is hardly conceivable that results obtained at Sophia are always applicable to every estate in the Colony ;

3. Serve as demonstrations for members of estate staffs many of whom seldom or never visit the main Station ;

4. In the case of variety trials serve as nurseries, conveniently placed for feeding the estates in the immediate neighbourhood.

With such experiments the estate carries out all the various cultural operations at its own expense, and, of course, utilises the canes from the experimental plots. The role of the Station and the Department of Agriculture is to :—

(a) Plan the proposed experiment ;

(b) Weigh, mix, and superintend in detail the application of the various fertilizers, or, in the case of variety trials, supply seed, when necessary, and superintend the planting ;

(c) Superintend any special cultural treatment if same is called for by the very nature of the experiment (otherwise the estate is requested to carry on as usual) ;

(d) Supervise the reaping of the plots and the weighing of the cane ;

(e) Make observations during the growing period, correlate and interpret the yield data ;

(f) Make the data available to the particular estate and the sugar industry in general.

During 1930, it is proposed to start five variety and at least three manurial co-operative experiments.

At Sophia a fertilizer experiment has been started in Field 17 East on plant canes of B.H.10 (12). The experiment seeks to determine the relative values of : (1) Sulphate of Ammonia, Kerazotine and Leathermeal (two nitrogenous manures of organic origin) as sources of Nitrogen when each is applied in such quantities as to bring 60 lbs. of Nitrogen per acre ; (2) 60, 75 and 90 lbs. of Nitrogen per acre as Sulphate of Ammonia. All fertilizers were applied in one dose.

In field 13W, a variety trial involving ten varieties so arranged that one plot of each occurs on each of the ten beds covered by the experiment, is already started.

In the new trials an effort will be made to take into account the age of maturity. Other things being approximately equal, it can be assumed that if an early and a late maturing variety be planted together and reaped early, the early maturing variety will prove more satisfactory. The reverse will be the case if the varieties be reaped late.

At this point, it may be well to call attention to the fact that if and when a thorough soil survey of the cane growing region is made, it will be necessary to revise the distribution of the sub-stations in accordance with that of the soil types which will be disclosed, so that the best varieties can be tried out on each type of soil.

The under-drainage experiment with bamboo (See *Agr. Jour. of B.G.*, II, p. 196) has made good progress and will be reaped in September, 1930.

Variety experimental trials were reaped during 1929 in Fields 2, 3, 5, 6, 7, 8 and 10 West at Sophia. This involved weighing over 3,000 individual rows in the field, and some 2,200 separate analyses followed by the tedious work of calculation, computation and checking.

The experimental mills worked quite satisfactorily and the convenience of having them in the compound was clearly demonstrated.

Some 63 punt loads of unwanted cane were cut and sold to Plantation Ogle, the revenue serving to increase the income of the Station by $1,099.55.

The Tables obtained from the trials just mentioned are not published as they were of a preliminary nature, but the figures, which have been distributed locally, have enabled a selection to be made of those varieties whose extension to sub-

station plots is desirable. These tests have also revealed other canes worthy of being further tested and have demonstrated the marked inferiority of several hundred on which no further effort need be wasted.

With a view to obtaining large numbers of cuttings for the estate plots, it was decided to abandon the idea of reaping, during 1930, the small and often unique plots of the better canes now existing at the Station, and to concentrate on cutting out all planting material from these as fast as it becomes available and establishing nurseries at the Station.

Other investigations started include trials with cane trash and rice straw as sources of material for synthetic farmyard manure made by the ADCO method.

About 50 soil samples were taken at Sophia for the Chemist-Ecologist, who is carrying out a survey of the soils of the Station.

GREEN MANURES & COVER CROPS.

Several new Cover Crop and Green Manure plants have been introduced and are under trial; they include *Crotalaria sericea*, *C. usaramoensis*, *Crotalaria* sp. ?, *Calopogonium muconoides*, several varieties of cowpeas, etc.

At Sophia itself, more and more attention is being paid to legumes and a large number of varieties is now under observation. Here too, as with the canes, effort has to be concentrated first on increasing the quantity of available seed. Experience here and on the estates points to Bengal Bean (*Stizolobium atterimum*), *Crotalaria striata*, and *C. usaramoensis* being the most satisfactory of varieties that have been under observation for some time. *C. juncea* is a rapid grower but does not seem as hardy as the others and there is some difficulty in obtaining a constant and adequate supply of seed. When the other two Crotalarias are once established on disused dams (traces) they furnish seed continuously.

Bengal bean makes an excellent cover and will come up amidst an astonishing quantity of grass and weeds over which it will eventually triumph, giving the field a uniform green carpet. Its main drawback seems the difficulty of hulling the seed.

Work with green manures has made considerable progress at Plantations Blairmont and Port Mourant, and other estates are becoming interested in this phase of our activities.

DOCUMENTATION, VISITS, ETC.

A progress report on the working of the Station was published in *The Agr. Jour. of B.G.*, II, pp. 194-198.

In the same issue of the Journal, pp. 167-171 there appeared an article by the Cane Agronomist entitled "Rototilling Cane at Plantation Blairmont."

Memoranda were prepared for the Director of Agriculture in connection with (a) The visit of the West India Sugar Commission, and (b) The Conference of Agricultural Officers to be held in Trinidad in early 1930.

An extensive card index of the periodic sugar literature has been started. All important papers, articles, etc., dealing with sugar production in its economic, agronomical, chemical, pathological, and engineering aspects are indexed as to subject and author. The subject cards bear a brief summary of the contents of the article, the name of the author and the reference to the place of publication. The author card bears the name of the author, the subject heads and sub-heads under which the article is indexed, and its source. Started in the month of June, the index already contains more than 200 author cards, and more than 100 publications have been examined for indexable matter. As the references accumulate, this card index will prove of great value not only to the officers of the Station, but to other scientists, sugar planters, etc., who are cordially invited to make use of it when in need of information.

The results obtained from the reaping of the 1929 experimental plots have been entered up in the variety card index which has now been brought up to date. This card index enables the history and record of the many hundred varieties which have been tested here to be easily traced.

The card index of tops distributed, which was much in arrears, has been brought up to date under both classifications, *i.e.*, by estates and by varieties.

During the period May 16 to December 31, 1929, the Agronomist paid one visit each to Plantations Houston, Diamond, Providence (Berbice), Friends, Rose Hall, Albion, Port Mourant, Springlands, Skeldon, Leonora, and Uitvlugt, and two each to Providence (Demerara) and Blairmont. On one visit to Blairmont and one to Providence (Demerara), he was accompanied by the Field Manager.

The Experiment Stations' Committee now meets frequently at Sophia. This enables the Members to keep in closer touch with the work being done.

Several Managers and Attorneys visited the Station and were shown around. It were better for the Station and the Industry that such visits be more frequent and especially that junior members of estates' staffs be encouraged to follow closely the work in progress at Sophia and the sub-stations.

The many courtesies extended to the Station and Staff by Managers and the personnel on sugar estates are greatly appreciated.

C. HOLMAN B. WILLIAMS,
Agronomist-in-Charge.

Members of the Sugar Experiment Stations Committee at the opening of the Mill Room, Sophi January 28, 1929

Mr G E. Anderson, Mr J C Gibson, Prof. J S. Dash (Chairman), Mr. R. Strang, H. Sir Gordon Guggisberg, Hon R E Brassington Mr C. Farrar, Mr A E. Craig

Mill Room and Field Offices, Sophia Sugar Experiment Station

AGRICULTURAL EXPERIMENT STATIONS,

DEMERARA COUNTY.

ANNUAL REPORT, 1929.

Staff.—The Agricultural Superintendent was absent from the Colony on leave of absence from April 13 to October 1. Mr. H. D. Huggins acted as Superintendent during his absence.

RICE.

Area.—The area under experiment in this crop was, during the period under review, 17½ acres; of this, 2½ acres were under progeny row plots for pure seed selection, and the remainder under proved varieties for seed distribution to farmers.

Distribution of Seed Padi.—5,616 lbs. of seed padi were brought forward from 1928, and 81,570 lbs. of paddy were reaped during 1929; this was disposed of as under:

		lbs.
Sold for seed purposes	...	40,162
Free distribution for seed	...	1,160
Used for planting on Station	...	880
Feeding Stock	...	4,060
On hand December 31, 1929	...	41,840
Lost by shrinkage	...	84
Totals	...	87,186

VARIETIES.

There are at present 50 varieties under cultivation. The first three named varieties were added during the year while the others were previously under observation.

Mexican Edith.—Presented by Messrs. T. Geddes Grant Ltd., from the Canada Rice Mills Ltd. of Vancouver, British Colombia.

Blue Rose.—This variety was obtained through the Mount Royal Milling Co., Montreal, and brought back from Canada by the Director. The seed was sown in the nursery on November 23, planted on December 23, and up to the end of the year showed poor growth.

Peru.—A few grains were obtained from Mr. Grant, who visited British Guiana in connection with rice machinery. It is a purple awned variety. Six seedlings are growing.

Aduturi No. 2 and A.E.B. 65.—Both from the Madras Delta (India), took seven months to mature, and grew to a height of 5 feet and over. These are evidently deep water rices; they lodge and get tangled badly, and have a habit of shooting from the nodes. As many as five heads are often found on one stem. The yield is poor and the straw excessive.

Blue Rose Variant.—This variant was selected from the original Blue Rose grown on this Station, which was obtained from Louisiana in 1918. The first generation grown in the Autumn of 1928 was somewhat mixed; but after careful selection in the two 1929 generations it is showing signs of a higher percentage of uniformity. The 1930 generation should be interesting.

Essequibo Blue Stick.—Work is still being carried on with this variety, and selections are being made with the object of obtaining a strain that will ripen more evenly and not shatter so easily. Needless to say, this will take time before any definite results can be arrived at. It is, however, a most promising variety.

Demerara Creole.—Since writing the last report I have ascertained from Mr. R. Ward, my predecessor, that this variety was obtained from a Mr. Wardle in 1904. This variety is now as pure as it is possible to get it—red and awned types have been completely eliminated—and selections are being made for immunity to disease, uniformity of grain, uniformity of maturity, and stiffness of straw. This is decidedly the most promising variety under cultivation.

Berbice Creole.—This variety, having shown no signs of improvement and no characteristics worthy of retention, has been discarded.

Selection Work.—Considerable progress has been made with the standardisation and acclimatisation of the varieties under experiment, and selections have been made with a view to fixing desirable characters, especially with regard to uniformity of ripening.

The most promising of the new varieties are:—

Carolina, Blue Rose, Lady wright, and Mexican Edith from the United States of America, C 14-31, and A 16-34 from Burma. There are also a few others that show signs of promise.

Carolina, Early Prolific Blue Rose, Lady Wright, Mexican Edith, Calora, Viola, Selection 300, Belize and Toledo retain their grain on the straw and are extremely difficult to thresh by hand; should these be ever extended it will be impossible to deal with them without threshing machines; this is characteristic of most of the American varieties.

The varieties in the progeny row plots are now being grouped according to periods of maturity, and not by country of origin. The majority of the early maturing varieties make poor growth, and the heads are small; in many instances

they flower in the nursery before they are five weeks old, e.g. Swarnalu, 1600, Hawaii Japan and Calora. On being transplanted the flowering stems died off and a fresh lot of stems appeared; these again flowered in four weeks. These varieties keep on tillering so that the heads are in all stages of maturity; they are evidently not suited to being grown under flooded conditions.

The following table summarizes the observations made and the results obtained with the imported varieties. The figures are compiled from the pure line selection plots; the plots were all planted with single plants 1" x 1" apart. The figures, are, however, recorded primarily for reference purposes and are of value and interest mainly to the agricultural staff. It is intended that systematic yield trials will be made in 1930 from which trials it is expected that results, which will have a dependable and significant bearing on the variety or varieties most suitable for local extention, will be obtained.

Variety	*Period of growth sowing to reaping Months.*	*Area of plot sq. feet*	*Yield per acre trans planted lbs*	*Degree of retaining grain on straw*	*Threshing by hand*
Kristna Kata Kulu	5	3030	6987	Retains grain	Fairly easily
Ak Kullu	5	780	5808	do.	do
Basangi	5	2250	5614	Shatters freely	Very easily
Konamani	5½	2700	5405	" slightly	Easily
A.E.B. 35	5½	2100	3837	Retains grain	do.
Garika Sanna Vari	4	1890	3757	Shatters slightly	do.
Atragada	5½	2130	3620	Retains grain	Fairly easily
Swarnalu	3½	1460	3342	Shatters slightly	Easily
Aduturi No. 2	7	120	1996	Retains grain	Difficult
A.E B. 65	7	1140	1719	do.	Easily
A. 16 - 34	5½	2550	6097	Shatters slightly	Easily
C. 14 - 31	5½	3390	5332	do.	do.
C. 14 - 8	6	2280	4165	Retains grain	Fairly easily
C. 19 26	5½	3660	4116	do.	do.
B. 15 - 1	5½	2280	2679	do.	do.
C. 15 10	6	2310	2508	do.	do.
D. 17 88	5	660	1518	do.	do.
Early Prolific Blue Rose	4	1170	2159	do.	Very difficult
Selection 300	3½	1360	2082	do.	do.
Lady Wright	4	1410	2008	do.	do.
Calora	4	720	1422	Retains grain	Easily
Viola	3½	960	1724	do.	Very difficult
Carolina	4	2250	1103	do.	do.
Pure 1600	3½	540	968	do.	Easily
Toledo	4	2070	2636	Retains grain	Difficult
Belize	4	2580	2061	do.	do.
Japan	3½	1290	3140	do.	Fairly easily
China	3½			do.	do.
75	5	3360	7763	Shatters slightly	Easily
H7	5	6440	6764	Retains grain	Fairly easily

Variety	*Period of growth sowing to reaping Months.*	*Area of plot sq. feet*	*Yield per acre trans-planted lbs.*	*Degree of retaining grain on straw*	*Threshing by hand*
79	5	5000	6438	Shatters very slightly	Easily
McKenzie Small	5	4800	6262	do.	do.
77	5	4590	5898	do.	do.
Hope	5 to 5½	3060	5832	Shatters slightly	do.
Blue Stick	5	4700	5820	Shatters badly	Very easily
Chinese Barley (Esse.)	5	3420	5693	Retains grain	Very difficult
78	5	3660	5522	Shatters very slightly	Easily
Loumi	4½	4740	5458	Retains grain	Fairly easily
McKenzie Large	5	5690	5229	Shatters very slightly	Easily
76	5	5920	5180	Shatters slightly	do.
H6	5	4830	4834	Retains grain	Fairly easily
Demerara Creole	5	6800	4830	do	do.
Blue Rose Variant	4½	3090	4750	do	do.
Barley (Essequibo)	4½ to 5	5000	4234	do	do.
Ramcajara	5	6600	3854	do.	do.
Blue Rose	4	1980	2464	do.	do.

OTHER CROPS.

PLANTAINS.

An area of land at the Station was selected, sufficient to permit 40 suckers being planted out at monthly intervals for a period of twelve months—the soil over the whole area being more or less uniform.

The suckers were obtained from the farmers at Pln. Hope, East Coast, where the soil is supposed to be free from plantain disease, and consisted of two types, 20 bulb and 20 sword. At the end of 1929 eleven monthly plantings had been made. This experiment should indicate when a crop may be expected from plants put in at any time of the year. This experiment is under the direct supervision of the Govt. Botanist, and a report on same will appear in due course.

BANANAS.

The varieties planted out have made good progress, and there should be a fair amount of material for extention during 1930. Dr. C. W. Wardlaw, Ph. D., D. Sc., F.R.S.E., Banana Pathologist of the Empire Marketing Board, spent four weeks in the Colony during August and September. Dr. Wardlaw's investigations were largely centred in determining the possibilities of establishing a banana trade in this Colony, and definitely ascertaining whether Panama Disease was to be found locally.

Dr. Wardlaw displayed much interest in the banana varieties growing at the Station and in the banana experimental plots which had, in some cases, been established on the same area for 3 years.

Observations were started on the Gros Michael variety and full notes of the size of bunch, height of tree, and area of leaves, will be made in each successive generation. This experiment will indicate the period during which a soil type, such as that at the Experiment Station, may be expected to support economically a banana cultivation.

Dr. Wardlaw also furnished some useful information with reference to the identification of some of the banana varieties in the Colony.

Beans And Peas.

A collection of these is being made and many are showing signs of promise. Seeds of four varieties of pigeon peas were obtained and are under cultivation, *viz.*, Local, Barbados, and two from Porto Rico. A further effort is being made to add to these.

Namudzi.

This millet was obtained through Mr. Sampson of the Empire Marketing Board in 1928; only one plant was reared from the imported seed, from which one head of grain was obtained. A small plot planted from this gave three crops in twelve months; it is hardy, ratoons well, and gives a fair yield.

A small plot is being run at Sub-Station Cecilia on sandy soil; small quantities of seed have been distributed to farmers.

Beet.

Results obtained from Beet trial plots were disappointing. This was due largely to excessive rains during the very young stages of the crop. The experiments carried out indicate that, whatever may be the practices elsewhere, it is advisable, locally, to sow beet in nurseries and later to transplant. If planting at stake is practised, the loss of seedlings during the early stages is excessive. The varieties which appeared most satisfactorily to withstand the unfavourable conditions were Crimson Globe and Eclipse.

Onions.

1819 sq. feet were planted in this crop. These did moderately well, produced onions of a fair size, and a great many produced two and three bulbs. The seed was sown in drills 6 ins. apart in a nursery carefully prepared, and were transplanted 4 ins. apart in the rows, and 6 ins. between the rows, at four to five weeks old. Great difficulty was experienced in curing the crop, about 30% rotting before they could be disposed of; these consisted mainly of the ones that produced two or more onions to the plant. The yield was 534 lbs. to the plot or 1,273 lbs. per acre.

Little trouble of this kind was experienced with onions grown on the sandy soils of Cecilia and there is every indication that considerably better results are to be expected normally on this type of soil.

Tobacco.

Three varieties of the heavier types of tobacco were planted at the Station in 1928 and early 1929, all of the varieties made fair growth. Caterpillars were very bad and caused some damage, although picked twice daily. Mosaic appeared on the last leaves produced but caused little real damage; all side shoots which appeared after the plants were topped were infested with it, as also ratoons after the plants were reaped.

Seven varieties were sown in September and October 1929; viz., Comstock Spanish, Kentucky One-Sucker, Vaughan's White Burley, Yellow Mammoth, Improved Gold Leaf, Ward's Burley and Warne. These will be reaped about February 1930. Kentucky One-Sucker, Comstock Spanish and Yellow Mammoth are the varieties which gave most satisfactory results and indicate that they may be worth more general attention by the local farmers.

Fodder Crops.

The Government Veterinary Surgeon having established areas of Uba Cane and Elephant Grass within the livestock compound, the areas planted in these, early in 1928, are being used entirely for free distribution and the land gradually utilised for other purposes as required.

An effort was made to establish Wynne grass-cuttings; root-stocks, and seeds having been obtained from the Agricultural Superintendent, N.W.D.—but without success; further efforts to establish this grass will be made in 1930.

GENERAL.

Orchard Trees.—In spite of the care given to this section, a good many of the budded citrus from Surinam have died.

The fruit dam has been pruned and certain useless trees removed. Most of the fruit trees have been identified and labelled.

An acre has been prepared and is being planted with a collection of grafted mangoes.

Drainage.—This has been maintained in a state of efficiency, the North and South side lines and the Live Stock area side line having been cleaned three times during the year.

Working Animals.—Two more oxen have been purchased, bringing the total to eight, thus enabling two ploughs to be worked continuously when required. These animals are in good condition.

Onions.—14 lbs. of white and 14 lbs. of red were imported and sold to farmers during the year.

Green Dressings.—Seeds of nineteen varieties were supplied to the Sugar Experiment Station, Sophia, and small quantities of seed of special varieties to sugar estates and farmers.

Tobacco.—The demand for tobacco seed was not as great as during 1928, but farmers visiting the Station displayed a more genuine interest in the cultivation and curing of this crop.

Fodder Crops.—Cuttings of Uba Cane, Elephant Grass, Guinea grass, and Demerara Primrose have also been distributed.

Maintenance and Improvements.—Minor repairs which were necessary for the maintenance of the buildings have been carried out by the staff at the Station. The boundary fencing has been maintained in satisfactory order.

A concrete drying flooor, 576 sq. feet, has been put down which greatly facilitates the drying and preparation of seed for our own sewing and distribution.

SUB-STATION CECILIA.

The work on this sub-station was continued during 1929. The following crops were grown :—

Ground nuts.—In addition to the varieties previously grown viz , Virginia Bunch, Spanish and Basse, a sample was received from Dr. Pettier, Venezuela, labelled Exotic variety ; this is a small nut somewhat after the Spanish type. The following gives particulars of results of each variety.

Virginia Bunch.—31.65 square rods planted ; period of duration 5½ months ;

Spanish :—3.58 square rods planted ; duration 5½ months.
Basse:—23,58 square rods planted duration 5½ months.
Exotic :—3.58 square rods planted duration 5 months

These nuts were all planted in July, and their poor yields may be attributed to the extremely dry weather during August to October. In 1928 the yields were :—

Virginia Bunch	1717 lbs, per acre
Spanish	1 lb. from 6.40 sq. rods.
Basse	258 lbs. per acre.

TOBACCO.

Twelve varieties were grown including two new ones, e.g., Vaughan's White Burley, and Virginia Broad Leaf. These were grown mainly for seed supply purposes and did not yield any data to which great significance could be attached. The varieties showing most promise are Kentucky One-Sucker, Comstock, Spanish, Yellow Mammoth and White Burley.

All varieties planted were badly attacked by Mosaic.

ONIONS.

These did well in this sandy soil; the results are as under :—

Variety	*Area planted*	*Wt. green onions per plot*	*Wt. green onions per acre.*
White	12 sq. rods	659 lbs.	16,475 lbs.
Red	8 „ „	363 „	13,612 „

These were sown in December 1928, and reaped during March and April 1929. A further area of 4.22 sq. rods of White, and 4.22 sq. rods of Red were sown in October 1929.

TOMATOES.

The following varieties were sown in October 1929 :

Variety	*Area*	*Date sown*
Golden Queen	4.25 sq. rods	9/10/29
June Pink	5.43 sq. rods	„
Crimson Cushion	1.74 „ „	„
Brimmer	1.70 „ „	„
John Baer	1.00. „ „	„
Bonny Best	0.75 „ „	„

The yields will be given in the 1930 report.

CABBAGE.

Two varieties were grown, and headed well, although badly attacked by caterpillars. The results are as follows :

Variety	*Date sown*	*Date reaped*	*No. of plants*	*No. headed*	*No. not headed*
Henderson's Succession	7/12/28	March & April 1929	84	54	30
Henderson's Autumn King	„	„	237	76	161

PINEAPPLES.

The following table will explain the position with regard to the varieties planted during 1927 and 1928.

Variety	*Origin*	*Remarks*
Red Spanish	Trinidad	Fair growth. Poor tillering.
Black Antigua	„	„ „ „ „
Sugar Loaf	„	„ „ „ „
Chocoma	„	Poor growth, very poor tillering.
Montserrat Red	B.G.	„ „ „ „

Variety	*Origin*	*Remarks*
Montserrat White	B.G.	Good growth. Good tillering.
Sugar Loaf	"	Good growth. Fair tillering.
Maipouri	"	Vigorous growth. Fair tillering.
Spanish	"	Fair growth. Poor tillering.
Bush	"	Very poor growth. Very poor tillering.
Buck	"	Fair growth. Fair tillering.
Baby	"	Very poor growth. Very poor tillering.
Maipouri	N.W.D.	Very poor growth. No tillering.

Dry adverse weather conditions during the latter part of the year greatly retarded growth and caused the death of many plants.

Soya Beans.

Only one variety (Yellow Mammoth) proved worth extending. The plot of 68 sq. rods planted in December 1928 was reaped in March and April 1929, and gave 162 lbs. equivalent to 714 lbs. per acre. A further plot of 72.5 sq. rods was planted on April 26, 1929. The distance on this occasion being 18" x 4". When reaped this gave 35 lbs. or 145 lbs. per acre.

A further plot of 92.17 sq. rods was sown on November 14, 1929, the distance being 18" x 4". The germination in every instance was poor.

These plots have been planted on the same area continuously, and the last sown has shown marked improvement in growth.

The following seeds were distributed to farmers and others from this Station during 1929 :—

Soya Beans	—89 lbs.
Broom Corn	—37 lbs.
Mung	— 7 lbs.
Urd	— 7 lbs.
Dwarf Bonavist	— 5 lbs.

The number of persons who visited this Sub-Station during 1929 was 472.

E. M. Peterkin,
Agricultural Superintendent.

EXPERIMENT STATION, NORTH WEST DISTRICT.

ANNUAL REPORT, 1929.

The total area of the Hosororo Station is 420 English acres ; about one half of this area is comprised of fairly steep hills of red clay with frequent outcrops of concretionary ironstone.

HILL LANDS.

Crop observations on the red hill soils are being carried out with budded and grafted fruit trees, cacao, nutmegs, poison plants, budded and seedling limes, pineapples, turmeric, ginger, guinea pepper, tonka beans, fodder plants, soya beans and other legumes, etc.

Budded Oranges & Grape Fruit :—About 10 acres are now planted with budded citrus plants, which include those introduced by the Director of Agriculture from Trinidad, and others budded at the Botanic Gardens, Georgetown, on sour orange stock from imported budwood. In this area the following are planted:—

Spanish Oranges	...	...	Homosassa, Parson Brown, Lue-Gim-Gong, Pineapple and Valencia.
Blood Oranges	...	...	Ruby and St. Michael's Blood.
Navel Oranges	...	...	Washington Navel.
Mandarin	...	...	Dancy and Satsuma.
Grape Fruit	...	...	Duncan, Marsh Seedless, Pernambuco, Walters.
Shaddock	...	...	Labuan.

On the whole these are looking well—especially those budded at the Botanic Gardens, Georgetown—have made good growth, are green and vigorous, and have been reasonably free from scale insects ; their greatest foe, so far, has been the coushi ant (*Atta cephalotes* and *Atta sp.*).

Limes :—The existing old lime cultivation has been extended by 5 acres—2½ acres have been planted with buds from selected lime trees budded on sour oranges stock and 2½ acres with seedlings. They are doing extremely well. The budding was carried out by labourers trained at the Station. The old lime cultivation is free from disease and insect pests. A start has been made to remove some of the balata planted 17 years ago, where the shade is too dense. Throughout the area devoted to permanent crops, attempts have been made to establish various legumes. These have included Dwarf bonavist, pigeon peas, *Phaseolus aconitifolius var. radiatus*, and *P. mungo*, *Crotalaria juncea* and *C. striata.* Of

these the Dwarf bonavist has been partially successful, the pigeon pea and *Crotalaria* thrive while the *Phaseolus* failed. Pigeon peas and Crotalarias give indications of being extremely useful, especially as they both appear to prevent the baneful effect of the beating action of heavy rains, and in addition the former is a valuable food crop.

Efforts have been made to raise good healthy stocks for budding purposes. At the end of the year there were 3,000 sour orange seedlings growing—the majority of which will be ready for budding during March and April, 1930. With difficulty, boys have been trained to bud. It is rather surprising to find that the aboriginal Indian boy is not at all apt at this work.

Budded and Grafted Avocado Pears:—The varieties propagated include St. Ann's, Rivers, St. Clair, Pollock and Rudder ; a few of these have died but most are making satisfactory progress and healthy growth.

Grafted Nutmegs :—A small number of grafted nutmegs are being grown in the area set aside for 'spices' where plants of the following are also being established :—cinnamon, tonka bean, turmeric, Jamacian ginger, guinea pepper.

Pineapples :—Experiments with Red Spanish, Smooth Cayenne, Ripley Black Antigua, etc., have been undertaken. Though at first they made poor growth owing possibly to the unsuitability of the site, with a little help from artificial manures and mulching, they have improved.

Cacao :—The Cacao, introduced by the Director of Agriculture from the upper reaches of the Berbice River, is growing satisfactorily. There seems to be every likelihood of cacao doing well on the hill slopes of these red soils, and interest in this crop has been awakened. Already there has been an increase in the area planted.

Papaws :—A variety of papaw which produces giant globose or elongated fruit does well on the hills—fruits weighing 8 to 12 lbs. each are not uncommon. Since good prices are obtained, farmers might turn their attention to their production, and also to the possibility of preparing papain.

British Honduras Mahogany :—About an acre has been planted with British Honduras Mahogany which has grown satisfactorily. During the year the young shoots of some of the trees were attacked by caterpillars—insect attacks and the effect on subsequent branching of the trees constitute a problem in British Honduras. The attack was promptly noticed and has been temporarily arrested. Specimens were forwarded to the Government Entomologist for identification.

Yams, etc. :—Small experiment areas of yams and corn were planted on the hills, the yams have not yet reached maturity ; the yield of corn was poor and a small second crop has been planted which has not yet been reaped.

Soil Erosion :—Considerable attention has been given to this all important question. It is quite obvious that if hill wash and conservation of humus are not taken into consideration, erosion will take place with astonishing rapidity, the consequences being disastrous. The writer estimates that, of the hill soils at the Station, more than half of the area is useless for agricultural purposes owing to erosion. There is evidence that in years past much of this area was cleared by aboriginal Indians, who practising Milpa agriculture, abandoned these clearings after 2 or 3 years. Such clearings quickly lost all humus with consequent erosion. They now consist of gravel and secondary forest, with numerous outcrops of concretionary iron-stone. During the year experiments have been carried out in the hopes of binding the soil and conserving humus. Cover crops of various legumes have been planted so as to assist in this respect, and also to increase organic matter and add nitrogen. So far pigeon peas and crotalarias are indicated as being the most suitable, and some success has already been obtained. As a permanent method to prevent erosion, a number of contour drains have been laid down, in such a way as not to preclude drainage, but at the same time to avoid excessive washing down during heavy rainy seasons. The method employed was suggested by the Director of Agriculture and there is every indication that is has proved satisfactory. On the parapets of the drains, where the earth is thrown in order to form a further protection, "Khus-khus" grass (*Adenanthera zizanoides*) has been planted. The conservation of humus will have to go hand-in-hand with a system of contour drains, if success is to be secured.

Terracing would probably serve the purpose even better, but under the present labour conditions it would not be practicable. Farmers engaged in hill cultivation have taken much interest in these experiments.

Poison Plants :—The area for plants of insecticidal value contains the following :—Black and White Haiari (*Lonchocarpus spp.*), Konami (*Clibadium surinamense* L.), Konaparu (*Euphorbia cotinoides* L.). Yarrokonalli (*Tephrosia toxicaria* Pers.), Dankanani (*Phyllanthus Conami* Sw.) and Hebitchioahabu (*Serjania* sp.) The last named failed, but will be re-established.

The haiari made excellent growth under partial shade, this condition being allied to their habitat in the forests. The white variety appears to be a quicker grower than the black. During the year the young shoots were attacked by an insect which produced mal-formation of the stems. Specimens were forwarded to the Government Entomologist, who is still investigating the matter. The damage done is by no means negligible, since the growth of the plant is considerably checked. The black variety—the more valuable of the two—has been more severely attacked than the white. The superiority of haiari (especially the

Black variety) to *Derris uliginosa* has attracted attention abroad, and already shipments are being made, possibly from material collected in Venezuela.

Great waste is certain to occur unless some supervision is exercised ; already one has to go far up the Kaituma, Arrau, and other rivers in this district to secure this plant, which is by no means commonly met with. On the other hand the less valuable plants such as konami, yarrokonalli, etc., are frequently seen in abandoned fields and around Indian Settlements.

The haiari was easily established, but cuttings of hebitchioahabu failed to strike. All these plants are used by Indians as fish poisons. Konami is also frequently used, apparently with success, as a remedy for snake bites.

PEGASSE LANDS.

About 15 acres of pegasse lands are devoted to coffee experiments, consisting of 10 acres of Liberian and 5 acres of the following species :—De Weveri, robusta, excelsa, stenophylla, Uganda, quillota, canephora, albeocuta, Klani-Pierre.

About 7 acres of this area has been planted in Gros Michel bananas, and half an acre in Giant Fig. The Gros Michel were planted in May and the Giant Fig in December, 1928. Flowering first appeared in March—June, 1929, and up to the end of December 747 bunches were reaped with an average weight of 35 lbs. per bunch.

An indication of the size of the bunches can be obtained from the following :—

No. of bunches	No. of 'hands'
1	12
1	11
13	10
54	9
120	8
256	7
221	6
71	5
10	4

In the early stages of the cultivation a temporary crop of bitter cassava was grown as a weed control ; only shallow tillage was afforded. Owing to the nature of the soil and to the prevailing wind, each banana plant had to be staked.

Soya Beans :— These failed on the pegasse, in spite of the fact that a portion of the soil was inoculated, and are now being tried on the hills with promising results.

Fibres, etc :—Small areas of Crowa (*Ananas sativus*) and Malva or Jumby Ochroe (*Malachra capitata*) are being tried on these lands.

Vegetables :— Small plots of onions and cabbages were planted, in which the farmers were much interested. Jerusalem artichoke was planted on a small area, and gave a yield quivalent to 26,000 lbs. per acre. An average field yield of 8,000 to 10,000 lbs. per acre might be excepted. As a substitute for English potatoes, and as a feed for pigs, it should prove useful to farmers. Farmers might find it a useful crop in their coffee fields as a weed control. Tubers have been distributed in the district.

The Government Entomologist and the Government Mycologist visited the district during the year, the latter in April and again in September.

GENERAL.

Frequent and regular visits have been made by the Superintendent to the farms, which occupy a very scattered area. Good work on the whole has been done, and a lively interest in Agriculture is being taken. The want of labour is still a draw-back to the district, more especially when the coffee crop is being harvested.

The coffee crop this year was late, and the bulk of the harvest will be reaped during January—March, 1930. There are indications of an excellent crop. Satisfactory crops of provisions and maize have been grown, but unfortunately the market prices have been poor. At one time eddoes were realizing only 60 cents per bag, and with freight at 16 cents per bag, it did not cover expenses to reap and send the crop to Georgetown, consequently the crop was allowed to waste in the fields. In consequence the farmers were again encouraged to keep pigs, so as to avoid risks of this nature.

Farmers have been impressed with the importance of keeping their peaty soils well drained.

Attempts at pruning have been made by some coffee farmers, and altogether there has been a distinct all-round improvement.

A field competition was held during the year, a sum of $120.00 being expended in prizes. The judges were impressed with the condition of some of the cultivations shown, expecially in the Aruka and Koriabo rivers. In the Aruka there is at least one farmer who will reap 1,000 lbs. of coffee per acre, whilst one

farmer in the Imbotéro obtained 21,886 lbs. from 20 acres. The average yield for the district is still, however, low, and is estimated at 400 to 500 lbs. per acre.

The position with respect to the finished product so far as coffee is concerned is far from satisfactory. Messrs. Garnett & Coy's factory at Aruka has not the capacity to handle most of the crop in addition to their own. The result is that the farmer whose crop is anything between 10,000 to 30,000 lbs of cured coffee has perforce to put down a small oil engine, pulper and huller to handle his crop, and that of his immediate neighbours. In no instance is the drying area commensurate with the area grown, so that if bad weather prevails the position takes on a critical aspect. The drier at Messrs. Garnett's factory has been a boon, but it is not large enough to handle very much 'outside' coffee—the position will be worse when more of their young area begins to fruit. At present in the district, apart from Garnett's factory, there are working, or in the course of erection, 8 factories, some consisting only of an oil engine and pulper. It is obvious that under these circumstances it is by no means difficult for a poor grade of coffee to be shipped from this district. A central factory is certainly a desideratum.

At the same time it must be remembered that many of the small farmers, though keen on utilising Garnett's factory when weather conditions are bad, yet do not display that same enthusiasm when conditions permit them to dry their coffee in the sun. Areas of cultivation are scattered over large distances, and include the Koriabo, Aruka, Imbertero, Barima and Waini rivers. Coffee berries prove a bulky crop to transport and handle. A barrel of berries (6 Kerosene tins) weigh about 180 lbs., which yield when thoroughly dried, about 15½ lbs. Farmers claim that handling the berries themselves they get 16 to 18 lbs. of dried coffee for every 180 lbs.—due, of course, to imperfect drying. The transport of wet parchments is next to impossible, as the amount of water it contains is considerable. During the year Messrs. Garnett & Co. erected a grader.

It is to be hoped that some arrangements will soon be made whereby a good standard of cured coffee is exported from the district.

There has been a slight improvement with regard to the question of peas and pulses, but with respect to livestock and poultry the position is very much the same as it was last year.

Owing to the illness of the Commissioner, the North West Farmers' Association did not play an important part during the year, but thereare signs of its awakening to renewed activity.

Wauna :— In September the Department undertook the control of the experimental plots at Wauna, which had been supervised by the Farmer's Association, at first, with eagerness. Latterly, interest appeared to have waned, and the cost of upkeep not being inconsiderable, the Association was glad to hand over the plots.

The sandy soils at the sub-station occupy a very large area of the district, and it is hoped by means of experiments to find crops which will grow and prove remunerative on those soils. Arrangements have been made to carry out a series of extensive and interesting experiments at the beginning of 1930, comprising citrus crops, pineapples, Arabian coffee, Haiari, coconuts, etc.

Waini :— There are only 77 acres cultivated on the Waini. There are large areas of fertile pegasse lands on this and other rivers, which would produce excellent crops of Liberian coffee and other products. Some of the prominent farmers in the Pomeroon appear to be taking an interest in this river and it is hoped that in the near future the land now lying idle will be under cultivation. Indeed the amount of rich, fertile, pegasse lands throughout the whole district which are untouched and on which Liberian coffee will fruit in fron 2½ to 3 years, is considerable.

There has been a total increase of 583 acres. The increase in the area occupied in coffee over that of 1928 has been 271 acres.

The total area occupied by East Indians in 978¾ valued at $11,796.00; 603 acres are under permanent crops.

Lime Factory.—Mr. H. Sampson, an ex-sugar estate manager, arrived in the district during the year, and in a very short space of time erected a lime factory and started operations in June. He had previously leased a cultivation in a semi-abandoned state of 70 acres of of limes, and has done a considerable amount of work in regenerating this area. He has offered to purchase limes at $1.20 per barrel. His factory worked well, and, single handed, he manufactured and shipped a quantity of concentrated lime juice, distilled oil of lime, and ecuelled oil. The energy and enterprise he has displayed is excellent for the district and interest in lime cultivation, for which large areas are suitable, has been awakened. Provided nothing happens to the market, we look forward to lime growing being undertaken on a considerable scale. So far as soil conditions are concerned this should prove a very attractive industry to future settlers.

Cattle breeding and the breeding of small stock :— Good cattle can be seen in the district and, though they are not many, it would seem that there is an opening for cattle-farming and sheep-raising on the hills.

Weather :— At the beginning of the year the weather was very dry and hot. The young citrus plants were only saved by judicious watering and careful mulching—this condition continued until April when rain fell, but was very unevenly distributed during the month. From May onwards the weather was favourable. The hill lands are very permeable and readily take a heavy rainfall. The heaviest daily precipitation was registered on May 17, viz., 3 ins. 005 parts the lowest was one part on August 11.

The following were the monthly totals :—

	1928 in. parts	*1929* in. parts
January	11.084	2.085
February	4.010	1.048
March	2.024	1.057
April	4.038	*6.071
May	15.047	17.011
June	16.078	17.033
July	12.072	14.094
August	11.000	11.052
September	5.031	9.023
October	7.029	8.031
November	6.089	15.008
December	14.025	6.068
	112.027	112.081

Revenue :— The revenue collected at the Station for the year amounted to $423.05 of which limes sold were responsible for $127.40.

EDGAR BECKETT,
Agricultural Superintendent.

*5 in. 042 parts in 2 days.

BOTANICAL AND MYCOLOGICAL DIVISION.

ANNUAL REPORT, 1929.

The following is the report of the Botanical and Mycological Division for the year ended December 31, 1929.

PLANT DISEASES.

SUGAR CANE.

Most of the sugar estates in the colony were visited during the year, but no serious fungal or bacterial diseases of cane were seen, or reported. The two most serious infectious diseases affecting this crop in the West Indies, namely Mosaic and Gumming Disease, have not either of them appeared locally as yet. To avoid their introduction it is necessary that every precaution be taken in bringing any new varieties of cane into the colony.

The Mosaic disease, though not yet known in British Guiana, occurs in Surinam, and I was enabled to see instances of it on an estate in the neighbourhood of Nickerie. The cane principally affected was D625, the variety so universally grown in this colony. At one time, I was informed, several fields had been badly infected, and no steps having at first been taken to control the disease, up to 100% infection had occurred upon 3rd and 4th ratoons. But by roguing, and replacing with the more resistant D109, or in the worst areas by Uba, the disease has subsequently been kept under control, and has never spread from the section of the estate where it originally appeared.

Root Disease.—This name is given to the withering and drying up of cane due to a poor development and functional failure of the root system, ascribed to environmental conditions rather than to the action of any definite organism. It has been suggested that an unduly high proportion of Magnesium in relation to the Calcium in the soil may be a contributory cause of the disease, and, in support of this theory, analysis of soils from some fields in which bad outbreaks have occurred has revealed an excess of Magnesium.

During the period under review, no very serious outbreaks of the disease were recorded. On estates visited early in the year, a certain amount of withering of cane was visible, which was directly attributable to the prevailing dry conditions, as appeared from the greatly improved condition of the cane seen on inspection of these same estates during the wet season.

Isolated cases of root disease are to be seen at all times of the year on most estates, and the occurrence of such affected stools directly adjoining others which are apparently healthy is one of the features of the disease. That the disease can be directly attributable to soil conditions in certain instances is indicated by its

disappearance in some cases on beds treated with filter press mud or pen manure. One case was noted where a field of second ratoons seen in July was "springing" very badly, much of the young cane withering and having to be "supplied." The field was treated with filter press mud before supplying, and no further withering took place. The resulting crop, however, was very poor, indicating the inherently bad condition of the soil concerned.

Ring Spot (Leptosphaeria sacchari).—This disease was only observed occurring to any extent upon one estate, on the West Bank, Demerara River, where it was present in a large number of fields, both upon plants and ratoons. It was chiefly confined, however, to the distal end of the older leaves, and the crop did not appear to be suffering any serious harm from it.

Chlorosis.—A peculiar chlorotic appearance of young cane leaves has been noticed on one or two occasions. One such case was observed in a field of six weeks old ratoons during the dry weather. Here many instances occurred, on one 'dam bed', of leaves showing almost complete chlorosis, or long white chlorotic strips. When seen again three months later, however, this condition had almost entirely disappeared.

In another case, a type of chlorosis was observed in a field where a number of different varieties of cane were grown for experimental purposes. The area affected had been forked about a fortnight before the chlorosis was observed. Half a dozen varieties were all found to be similarly affected, the appearance varying from cases in which the whole leaf appeared chlorotic, with the exception of the midrib, to others where the chlorosis was confined to patches, or narrow strips, or simply a chlorotic flecking of the leaf. The canes concerned were all young ratoons, and the observations were made during the wet season. The chlorosis was confined for the most part to the outer leaves, and on the older of these the chlorotic areas tended to dry out. In this instance, however, the field was visited one month later, and even by then chlorotic plants were only to be found with difficulty.

In both cases, therefore, it appeared that the abnormal condition was due to some untoward environmental factor, the influence of which had only made itself felt over a short period.

Sooty Mould.—A species of *Capnodium* is to be found upon cane leaves attacked by the Yellow Sugar cane aphis, the fungus subsisting upon the 'honey dew' produced by the insects. Though entirely secondary, it is one of the most conspicuous features of the insect attack.

Tangle Top.—A twisting and entanglement of cane 'tops' is sometimes to be seen, due apparently to some mechanical friction, whereby the leaves of the top are held together. The growth of younger leaves from below then causes these older leaves to split and tangle, and wrap around the young leaves. Affected leaves, however, retain their normal colour and no serious damage is done. A similar condition is reported from most cane-growing countries.

RICE.

No serious fungal disease of this crop is known in the Colony. One or two minor affections, however, were observed on the plots at the Botanic Gardens Experiment Station, which appeared to be related to prevailing weather conditions.

"*Man Rice.*"—This name is given locally to a disease which periodically affects a small percentage of plants in the rice beds. The symptoms first become apparent two or three weeks after transplanting, when isolated plants here and there are observed to be taller than the majority of the crop, and somewhat spindly and chlorotic in appearance. Usually one or two such plants occur in a clump in which the remainder are healthy. The Demerara Creole variety seems to be more liable to the disease than other varieties grown at the Experimental Station.

Examination of the root system shows that affected plants have a decidedly poorer root devolopment, especially as regards the finer feeding roots and root hairs. Many of the affected plants die, and, in others, either no flowering heads form, or those which do are poorly developed and do not open. These symptoms resemble the disease known in America as "straighthead", but the local conditions differ from it in the fact that the plants become chlorotic, those affected by "straighthead" being described as a darker green than normal.

Attempts at isolation of any possibly causative agent from the base of affected stems, which usually become somewhat discoloured, yielded a number of common soil organisms. These include several species of bacteria, a species of *Fusarium* resembling *F. moniliforme*, and a sclerotial fungus which was identified as a strain of *Corticium solani*. The occurrence of the disease, which causes very little loss, would appear to be correlated to some extent with weather conditions, as it seems to occur more commonly when heavy rains accompany the early development of the crop. During the second crop of the year, when drier weather prevailed at the period immediately following upon "planting out," "Man Rice" was practically non-existent at the Experimental Station.

"*Light Ears*".—In a plot of 'Blue Rose' which flowered at the beginning of August, a large percentage of 'light ears' occurred. The grains at the top of the ear failed to develop, the glumes drying up and falling away. Sometimes almost the whole ear was so affected, the symptoms becoming visible as the ears emerged. Later planted beds of the same variety, however, flowered quite normally in September, and the above mentioned appearance was attributed to the heavy rain which prevailed before and at the time of flowering, and which had caused an excessive amount of vegetative growth. Examination of affected plants disclosed the presence of no fungus or other organism.

COFFEE.

Sclerotium disease. (S. coffeicolum.)—Two visits were made to the North West District in connection with this disease of the Liberian coffee. In April experimental spraying was carried out to test the possibilities of new machines of the

compressed air knapsack type. These proved satisfactory, and experiments were started in September upon trial areas, to test the efficacy of spraying with varying strengths of Bordeaux mixture, and to discover whether this method of control, if successful, will prove economically advantageous. Data as to costs of spraying have been secured, but further information must await the picking of the crop. The experiment will have to be repeated over several seasons if reliable data are to be obtained.

The outbreak of the disease in the later months of 1929 was mild, and considerably smaller than that of the preceding year. Some interesting observations were made upon the occurrence of the disease on other plants. and the causative fungus was found in the 'bush' away from the coffee grants, and also in another part of the colony. Details of these observations, and of the spraying carried out, will be published in Vol. III, No. 1 of this Journal.

Wilt.—The wilting of isolated trees of Liberian coffee, due apparently to physiological factors, was again observed.

Brown Eye Spot.—(*Cercospora coffeicola*) occurred upon seedlings of the Excelsa variety growing in the Botanic Gardens nursery.

COCONUTS

Coconuts are principally grown as a subsidiary crop, and receive very little attention in the way of cultivation. In addition, they are planted in many cases on a heavy clay soil, quite unsuited to them. Where growing upon a suitably porous soil they are seldom affected by wilt, which is the principal cause of loss to this crop.

Wilt.—The wilt disease of coconuts has been observed to a greater or less extent wherever the palms are planted upon the stiff clay soils of the coastal belt, and appears to be entirely comparable to that occurring in Trinidad, and like it to be primarily attributable to the unsuitable environment and lack of proper cultivation. On two estates in Essequibo the disease spread considerably during the dry weather at the beginning of the year. Affected trees here were not only those upon a heavy clay, but on a narrow sand reef crossing the estates, where many trees had died in the course of the preceding years. The soil on this reef, however, was of very poor quality, a loose sand, lacking in texture, and not of the nature which coconuts prefer. In this locality, many of the trees which were not wilted, though sometimes bearing profusely, produced nuts which were small. These often contained no endosperm, or the latter was so thinly developed that the testa was visible in patches.

In considering this disease, however, the possibility must be borne in mind that fungi or bacteria, though not the primary cause of it, may play a secondary part in its extension, for it is usually noticeable that trees wilt in groups, suggesting the spread of some organism amongst palms already weakened by environmental conditions. For this reason the cutting down and burning of wilted trees is to be advocated. In one case, isolations made from the discoloured tissue at the top of a diseased stem (below the rotted area) gave rise to *Thielaviop-*

sis paradoxa. Observation also suggests that certain types of palm are more resistant to the disease than others, a tree here and there remaining healthy when all its neighbours have died. Proof of this would however be a very difficult matter, as, apart from the time required before selected trees bore fruit, the effects of the disease do not usually become visible till the trees are at least fourteen or fifteen years of age.

"*Red Ring Disease.*"—One case of this disease was reported to have occurred in the colony some years ago, but its appearance has never since been verified. Stem tissue from a wilted tree sent for examination early in the year revealed the presence of nematodes, and 'Red Ring' was suspected. On inspection of the tree '*in situ*' however, it showed a reddened zone some one inch broad at the periphery of the trunk, and continuing some 5-6 feet above the ground, the remainder of the stem appearing healthy. Cutting the bark at the base of the tree produced a slimy ooze. The crown of the tree was dead, as in normal advanced cases of wilt. In this case the red ring was not typical of that found in trees affected by the disease of that name, when it usually occurs at a little distance in from the periphery of the stem. Furthermore, a number of other wilted trees adjoining the one in question were examined, and in no case was a red ring to be seen, or any nematodes to be found. It was therefore considered that the presence of the nematodes in the one case was of an entirely secondary nature. A watch was kept subsequently in the field concerned for any cases of red ring in wilted trees which were cut down, and no further instances were reported. The tree in question was burnt immediately.

Disease of Nuts.—A peculiar disease of nuts is commonly to be seen in many coconut growing areas. As the nuts develop, and are nearing maturity, brown areas, originating at the base of the nut, spread over the surface. Often only a small proportion of the nut is affected, but sometimes the whole surface may be disfigured. On inspection, these brown areas are seen to occur in portions of the surface on which the cuticle and epidermis have apparently died, and failed to expand with the development of the underlying tissue. In consequence there arises a network of ridges covered by dead cuticle and epidermis, in between which are depressions, caused by splitting, where the underlying fibrous tissue is exposed, and has dried and become brown. The effect as a rule seems to do little damage beyond the disfigurment of the nuts, and is only 'skin deep', the tissue beneath the dead outermost layer being quite healthy. The cause of this appearance is so far undetermined.

PLANTAINS.

Wilt.—This disease has hitherto been considered to be due to a species of Bacterium, and in connection with it a visit was paid to the West Coast and West Bank in September, in company with Dr. C. W. Wardlaw, Banana Pathologist of the Imperial College of Tropical Agriculture. Wilted plantains were examined, and also wilted plants of the variety of Banana known locally as Cayenne, and

material taken by Dr. Wardlaw to Trinidad for examination. At first bacteria only were discovered, but a subsequent supply of wilted plantain material yielded several strains of *Fusarium cubense*, the causal organism of Panama Disease. A further supply of diseased plantain suckers was obtained, and isolations made both by Dr. Wardlaw and myself. In both cases *F. cubense* was obtained in culture in addition to a number of bacteria. The relative parts played by the fungus and one or more of the bacteria remains to be discovered.

BALATA.

'*Die Back.*'—Further examination was made of the die back disease of Balata trees *Mimusops* sp. growing at Hosororo Experiment Station, North West District. The trees concerned, which are about 17 years old, are growing upon a steep hillside, and a large percentage of them has been affected. In early stages of the disease, twigs are found dying back, and the leaves withering. At first such dying stems show brown patches at intervals under the bark, later becoming entirely brown and dry. An early symptom of affected twigs and branches is the cessation of the flow of latex, which normally takes place immediately upon wounding the bark. Finally, such dead twigs or branches are cut off from the healthy part of the plant, a definite cambial layer forming at the base of the dead limb. On these dead branches various pycnidial fungi are to be found. As the disease progresses, increasingly larger branches become dried out in this manner, until finally the whole tree dies. Examination of the roots of affected trees, however, shows no definite discoloration, and they seem to be healthy and functional. Only after the death of the tree both trunk and roots are bored by insects.

It has been observed in the case of an apparently healthy Balata tree in the Botanic Gardens, that a number of twigs and small branches on the older and inner parts of the tree, are cut off by formation of a definite layer in the manner described above. This then would seem to be a normal process, which in the case of the trees under discussion has been carried to an abnormal extent, finally involving the whole tree. The causative factors are uncertain, but it is to be noted that the diseased trees are growing upon a steeply sloping hillside, the soil of which has been subjected to considerable leaching and erosion by rainfall.

MISCELLANEOUS CROPS.

Cacao.—Plantations visited on the Berbice and Demerara Rivers were all found to be infected with 'Witch Broom' Disease. This disease, however, was not observed on the few cacao trees to be seen in the North West District.

Tobacco.—The crop at the Experimental Station was affected by Mosaic disease.

Cover Crops.—A wilt of Sunn Hemp (*Crotalaria juncea*) at Sub-station Cecilia was due to *Fusarium vasinfectum*. Bengal Beans (*Stizolobium* sp.) and Black Eye Peas (*Vigna catjang*) at the Experimental Station were slightly affected by leaf spots due to *Cercospora* sp.

Tomatoes.—In various localities these were affected by Blossom End Rot, a disease due primarily to environmental conditions adversely affecting the water supply. A short note on this disease was published in the *Agr. Jour. of B.G.*, Volume II, No. 3, page 207. At the Experimental Station a wilt of Tomatoes was found to be due to *Fusarium lycopersici.*

IMPERIAL BUREAU OF MYCOLOGY.

Cultures of a number of fungi have been sent to this institution, and thanks are due to the Bureau for determinations received, and also for the loan of literature unobtainable in the Department's Library.

The Bureau is collecting lists of the diseases of Economic Plants in various parts of the Empire, and in response to their request, a list of known diseases of local economic crops was prepared and forwarded to them.

OTHER INVESTIGATIONS.

WEED ERADICATION.

The eradication of the weed *Antidesma Ghesaembilla* Gaertn. has been continued in the Botanic Gardens. An account of the methods employed, together with the costs of the operation, has been published in Vol. III, p. 84 of this Journal.

FRUITING OF PLANTAINS.

An experiment has been laid down at the Experimental Station, in conjunction with the Superintendent. Its object is to determine whether a supply of fruit can be obtained from plantains, which will be more evenly distributed throughout the year than is generally the case. To this end a bed has been planted on the first day of each month throughout the year, employing suckers of two types, 'bulbs' and 'swords'. Followers have been allowed to develop after varying periods.

INVESTIGATION OF PASTURELAND.

In conjunction with the Government Veterinary Surgeon and the Government Chemist-Ecologist, a short visit was paid to the Rupununi Development Company's ranch at Waranama, on the Wiruni-Ituni Savannahs, Berbice, and a survey made of the available pasture grasses, etc. The results of the survey were made known in a separate report.

JENMAN HERBARIUM.

Collections of plants for the Herbarium were made from time to time during the year. A number of specimens were obtained in the North West District and on the Berbice Savannahs, and sheets of these have been despatched to the Kew Herbarium for determination and reference. In addition, a number of sheets of Savannah Plants were sent to Dr. Gleason, at the New York Botanical Gardens.

I was enabled to join the Oxford University Scientific Expedition for a short time, on the Moraballi Creek, Essequibo River, and, in conjunction with the Botanists of the expedition, made a collection of some one hundred specimens of fungi. These were despatched to Kew for determination with the other plant collections of the Expedition. The fungi of the colony are almost unknown, and it is hoped that the collection made by the Expedition will add considerably to our knowledge of them. The Expedition's large collection of other plants will be a valuable contribution towards the compilation of the proposed Flora of British Guiana. Special attention was paid to the identification of various forest trees, hitherto largely known only by Indian names, and the results of their work will have a value far more than academic.

A duplicate set of plants collected by members of the Forestry Department in the North West District has been received from that Department.

In the Herbarium itself a large number of old sheets, unnamed, or only partially named, have been sorted and arranged so that they can now be dealt with systematically as time permits.

The sheets of Filices, Lycopodiales and Fungi sent to Kew in 1928 have been returned, with the exception of some of the fungi which have still to be named. Determinations of a number of these fungi, together with some collected more recently in the North West District have been received from Kew.

The Herbarium Assistant, Mr. N. Persaud, has been responsible for the mounting of specimens collected during the year, and the general routine work of the Herbarium. In addition to this, he has continued to take charge of the work in connection with the eradication of the Antidesma in the Gardens, and to his careful supervision the successful results so far obtained are due.

E. B. MARTYN,
Botanist & Mycologist.

REPORT OF THE CHEMISTRY DIVISION.

APRIL, 1929 TO DECEMBER, 1929.

The following is the report of the Chemical Division for the period April to December, 1929 :—

I assumed duty as Chemist-Ecologist under the Colonization Scheme on April 2, 1929. The work of the Division during the period under review is here briefly summarised. Full reports have subsequently appeared elsewhere.

During the early part of the year 1929 the Chemical Division of the Department was reorganised. A small laboratory was fitted up at the Head Office of the Department, Broad Street.

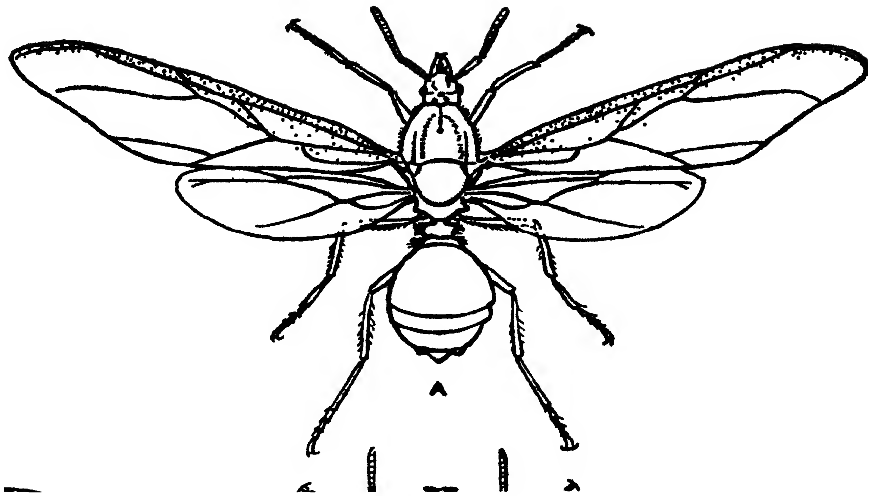
NORTH WEST DISTRICT SOIL SURVEY.

On April 9, a detailed soil survey of an area of the North West District of the colony was commenced. The final report, which has since appeared as *Chemical Bulletin No. 1.* of the Department (1930), was completed on August 22, 1929. Roughly 156 square miles of country were surveyed, consisting of 103 square miles of pegasse swamp, 40 square miles of sand hills and 13 square miles of lateritic clay hills.

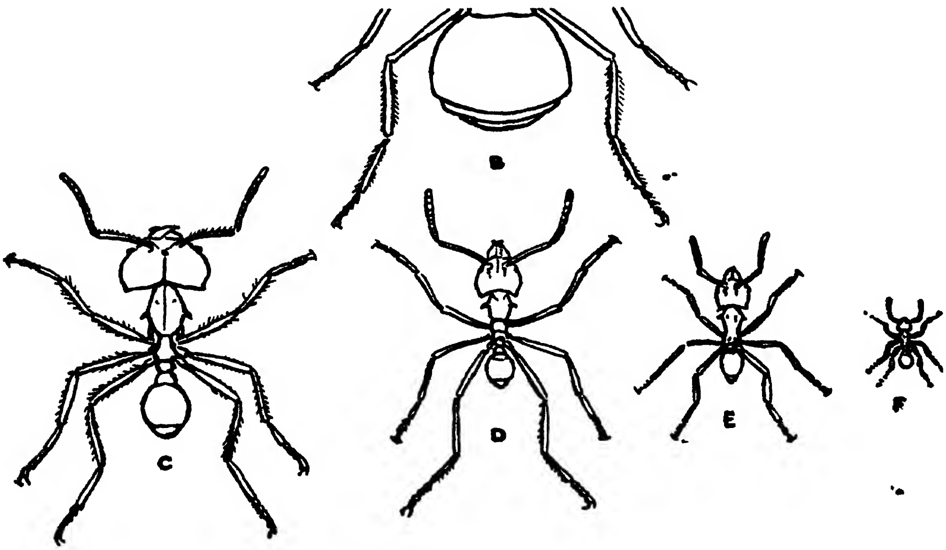
On the score of the expense and difficulties of drainage the pegasse swamps were ruled out of consideration as far as the suggested colonization scheme was concerned. Limited areas of virgin pegasse, situated on the river banks, where drainage is comparatively easy, will probably be empoldered and cultivated in the course of normal expansion. Attempts should be made to discover a permanent economic crop, other than Liberian coffee, for the pegasse soils. The lateritic clay soil type, which supports good citrus cultivation, is, for the most part, already occupied. A large proportion of the remaining areas of this soil type occurs on hillsides where the slope is so precipitous and the soil so shallow that cultivation is precluded. The sand hill soil type, which appears to be representative of considerable areas of the interior of the colony, should not be settled by an agricultural community until it has been shown by experiment that economic use can be made of such lands.

An experimental area at Wauna Creek, typical of the sand hill soils of the vicinity, has been established. The feasibility of the extensive colonization of this and other areas of the interior depends upon the results obtained with economic crops at this station. In this connection, it should be remembered that a fair amount of agricultural experience on this type of soil has been obtained at the up-country experiment station at Zanderez, Surinam. A considerable amount of valuable information on the subject of the cultivation of sandy soils

PLATE V



This plate has been unavoidably delayed and should be inserted in Vol. III, No. 1, facing p. 25.



COUSHI ANTS, *ATTA CEPHALOTES* L. × 1¼.

A, male ; **B**, winged female ; **C**, so-called soldier ; **D**, large worker ; **E**, smaller worker ; **F**, smallest worker or nurse.

(Redrawn after Cambridge Natural History).

could be collected were an officer of this Department given the opportunity of visiting the experiment station at Zanderez.

Examination of Cane Juice Samples.

During the months of April and May, 1, 110 samples of juices, obtained from cane samples crushed at the Sophia Sugar Experiment Station, were examined. Determinations of the sucrose content of bagasse should be made in these investigations. Until the requisite machinery for disintegrating samples of bagasse is installed only samples of juices can be analysed.

Survey of the Waranama Ranch.

During the period August 28 to September 4, in company with the Government Veterinary Surgeon, the Government Botanist and Dr. C. W. Wardlaw, Plant Pathologist of the Imperial College of Tropical Agriculture, Trinidad, a survey of the soils and pasture grasses occurring at the Waranama Savannah, Berbice River, was carried out. The soils consisted, mainly, of acid sands, deficient in lime, phosphate, potash and organic matter. The grasses of the Savannah, all of a xerophytic type, were markedly deficient in essential minerals. The improvement of the pasture grasses by manurial treatment would probably prove uneconomic. The regular administration of bone meal was suggested as the most promising means of rectifying the more important mineral deficiencies of the savannah grasses.

Acknowledgments.

It is a pleasure to acknowledge the fact that the work carried out during the period under review was made possible by the co-operation of the Scientific Assistant, Mr. C. L. O. Bourne, and the Laboratory Assistant, Mr. L. A. Robinson. I appreciate greatly the considerable amount of careful work carried out by these officers.

I wish to record the kindness of the Government Analyst who, by lending me certain supplies, tided over the awkward period which is experienced when a laboratory is first established.

R. R. Follett-Smith,
Chemist Ecologist.

ENTOMOLOGICAL DIVISION.

ANNUAL REPORT, 1929.

The following is the report on the working of the Entomological Division of this Department for the year 1929.

STAFF.

The Staff of the Division has remained unchanged during the year.

On March 21, I was appointed to act Deputy Director of Agriculture and continue to perform these duties at time of writing.

In addition, from July 15 to October 31, I acted Director of Agriculture during the absence of Professor J. S. Dash on a mission to Canada.

In November the West Indian Sugar Commission visited the Colony to carry out inquires into the state of the industry. In the absence of the Director from the Colony I prepared a memorandum on certain aspects of the sugar industry and causes relating thereto which was submitted to the Commission through Government. Another memorandum dealing exclusively with sugar-cane insects was prepared also and submitted to the Commission, and in addition I gave oral evidence before the Commission with regard to the insects affecting this crop.

It can be understood, therefore, that, without a trained assistant in the Division, entomological investigations have suffered to some extent as the result of these multifarious duties. Nevertheless, it will be observed that a number of entomological investigations have been undertaken during the year under review, and considerable progress maintained. This has only been accomplished, however, by the performance of a considerable amount of work, both overtime and out of official hours by myself and the junior staff. I take this opportunity, therefore, of expressing my appreciation of the manner in which the staff of the Division have performed their duties during the year.

PRINCIPAL CROPS.

SUGAR-CANE.

Early in March Dr. J. G. Myers of the Imperial Bureau of Entomology, who is engaged on special investigations for the Empire Marketing Board, visited the Colony, remaining until the middle of June. Dr. Myers was accompanied by Mrs. Myers, who is his official collaborator. While in the Colony Dr. Myers paid special attention to the Small Moth Borers of sugar-cane, *Diatraea* spp., investigating the question of the biological control of these insects. Dr. Myers has submitted certain suggestions with regard to future research on *Diatraea* in this Colony and these are at present receiving consideration of Government,

The control measures practised in the Colony against these insects, while they have gone some way to mitigate the damage inflicted, must, in most cases, be looked upon merely as palliatives. When it is recognised that over 90 per cent. of all stalks of cane in the Colony are injured to the extent of about 25 per cent. of their joints, some idea can be gained of the extent of the damage inflicted. To convert this loss into sugar with a reasonable degree of accuracy is at the present time a somewhat difficult undertaking, but there cannot be the slightest doubt that the amount involved amply justifies the institution of early and extensive research.

It is now recognised that the control of *Diatraea* in British Guiana is an exceedingly complex problem, and it is only by careful and extensive research that there is any hope of arriving at a solution. In addition to sugar-cane these insects attack growing rice, at times causing serious damage, while there are some six other host-plants that may harbour the pest. On the other hand small moth-borers are attacked by a number of parasites in this Colony. Just what parts the various elements play in this entomological complex is not understood at present, and until this is known little more can be done to improve conditions or to suggest additional measures for the control of the pest.

In parts of the Colony this crop suffered both during the mid-year and end-year rainy seasons from sharp attacks of the Larger Hardback Beetle, *Dyscinetus geminatus* F. The outbreaks were the most severe that have occurred for many years, and in some instances necessitated a large amount of "supplying." Various means were adopted for dealing with the pest according to the conditions prevailing, and included the use of traplights and flooding.

Investigations have been commenced on the life-history and control of this and other related beetles.

At the same time there were outbreaks of a lesser extent of the Small Hardback *Dyscinetus bidentatus* Burm. This insect more often attacks sugar-cane than the previous species, and can be very destructive. On one estate that came under my notice it inflicted an appreciable amount of damage during the outbreak last year.

Both insects, but principally *Dyscinetus geminatus* F., also occurred at the same time on one of the Golf Courses where they severely damaged the fairways. Investigations showed them to be present in large numbers in the waste grass-lands in the vicinity of Georgetown, and thus the periodic appearance of hundreds of the adults around the electric street-lamps, and even in the houses in certain parts of the city, was accounted for.

Rice.

With the extension of this crop, and the attempts that are being made to obtain rice of a quality suitable for an export trade, the control of the insect pests of rice is assuming more importance. In this respect attacks by the Paddy Bug *Mormidea poecila* Dall. may assume considerable importance, for in severe outbreaks this pest damages the grain to such an extent as to render it quite unsuitable for the export markets. Most important in this connection is the fact that unless careful examination be made of the paddy this injury is not apparent, but on the rice being milled the effects are immediately visible, in the form of blackened areas in the grains if the damage has been extensive enough, or as small opaque areas when of a lesser extent—the result of the punctures made by the bug. Apart from the general unsightly appearance caused in this way, a considerable proportion of the grain may be rendered worthless, and even when the damage is of a less extent it results in a large proportion of the rice being broken in the process of milling. These defects reduce the market value of the rice even locally, while they entirely disqualify it for an export trade.

Another important pest of rice in the Colony is the Small Moth Borer, *Diatraea saccharalis* F. This insect, which is one of the destructive small moth borers of sugar-cane, at times causes serious injury to rice. Its status with regard to each of these crops is complicated by its presence in the other, and it requires to be thoroughly investigated. Indeed any investigation of this insect in sugar-cane would not be complete without a careful inquiry into its presence in rice.

Coconuts.

Investigations on the Coconut Stem Borer, *Castnia daedalus* Cram., were continued during the year as opportunity occurred, but owing to the pressure of work in other directions it was not possible to devote as much time to this insect as was anticipated.

The life cycle of the insect has been completed, and has been found to occupy about a year. The periods of the different stages of the insect are approximately as follows—egg period 16-18 days, larval period about 340 days, pupal period about 38 days. There is a considerable variation in all of these periods, and the causes for this are at present not understood.

While a good deal may be done in combating this insect by simple hand-collecting methods and the general cleaning of the palms, the habits of the insect render such measures tedious and somewhat expensive, and an endeavour is being made to find other means of dealing with the pest. Some preliminary work of this nature has been undertaken, but there remains a good deal more to be done in this direction before any definite recommendations can be made.

OTHER CROPS.

Ground Provisions.

Tannias :—During the year investigations were continued on the Tannia Beetle or "Cockle" as it is called in the North Western District. Another visit was paid to the District in July and certain points cleared up.

The life-history of the insect was investigated in the laboratory, supplemented by field observations, and it has been ascertained that the life cycle occupies about a year. A large proportion of this period is spent in the adult stage and passed underground.

Work has also been carried out on control measures. An illustrated paper on this insect dealing with the life-history, and giving preliminary recommendations with regard to its control, will be published in the forthcoming number of the Agricultural Journal.[1]

OTHER INVESTIGATIONS.

Silk.

The report of the Imperial Institute on the silkworm cocoons submitted to them for examination, and which had been reared from eggs supplied by the Institute, was received in November last. The report unfortunately is not favourable, and it is stated that, after an examination of the cocoons, the Advisory Committee on Silk Production are of the opinion that taking into account the results obtained from the experimental rearing under consideration and the practical difficulties which have been experienced in raising the worms in the Colony since the trial cultivations were first undertaken, the general climatic conditions obtaining in the coastal region of British Guiana appear to be unsuited to the raising of silkworms with the certainty of success that is essential if an industry is to be established.

Plant Protection Service.

Inspection and *Fumigation* :—This part of the Division's activities has continued during the year, and there has been a marked increase in such work.

Legislation :—A draft bill has been prepared and submitted during the year, in conjunction with the Botanist and Mycologist, in which provision is made for the dealing with pests and diseases both in respect of outbreaks occurring in the Colony and the prevention of their introduction.

The importance of legislation for the introduction of insect pests and the institution of rigid inspection cannot be too strongly emphasized. The two recent examples of the introduction of the European Corn Borer and Mediterranean Fruit Fly into the United States of America are outstanding examples of the possible results that may follow the introduction of dangerous insect pests from other countries.

[1]Published; *Agri. Jour. of B.G.* III, pp. 11—23, (Fig. 1; Plates I—III.)

Sale of Insecticides :—During the year arrangements have been come to between Government and a firm of druggists in Georgetown for the supply of certain insecticides to farmers and others at fixed prices. This is an endeavour to supply cultivators with the insecticides most used in the Colony at reasonable prices, and will be given a trial during the present year. Ample publicity will be given to make the undertaking known, and it is hoped that it will be taken advantage of by those concerned.

Tours and Visits.

A tour was made of the North Western, Pomeroon and Essequibo Coast Districts in June and July, and a visit was made to the County of Berbice in September. In addition, several sugar estates were visited during the year as well as farms and villages in the County of Demerara.

Publications.

During the year the following papers were prepared and published :—

A Preliminary Study of the Coffee Industry of the North Western District, British Guiana—Agr. Jour. of B.G. Vol. II, No. 3, pp. 130-156, figs. 2, Tables 5, September, 1929.

A paper entitled "*Butterfly Migrations in British Guiana—II*" submitted to the *Entomological Society of London* was read at a meeting held on 2nd October, 1929, and will appear in the *Transactions* of the Society at a later date.

Collection and Library.

The collection of insects has been maintained in good condition, and the catalogues kept up to date. A number of insects was added to the collection during the year. At present there is a need for additional cabinets. The preparation of a catalogue of British Guiana Insects was continued ; it is hoped that in the coming year it will be possible to make a start on the publication of a list of some orders.

Consignments of insects have been sent to the Imperial Bureau of Entomology from time to time during the year and determinations received. Thanks are due to the specialists who have made these determinations, and to the Bureau for the prompt and efficient manner in which the determinations were obtained ; the Bureau has been very helpful also in obtaining determinations of specimens other than insects submitted on different occasions by the Division.

The Library of the Division has been maintained in good condition, and a number of volumes have been bound during the year.

L. D. Cleare, Jr.,
Government Entomologist.

VETERINARY DIVISION.

ANNUAL REPORT, 1929.

The following is the report of the Veterinary Division for the year 1929.

ANIMAL HUSBANDRY.

Generally, the management of all stock is primitive. Horses, mules and donkeys receive a certain amount of attention, but cattle and small stock are, as a rule, left to fend for themselves, The attitude of peasant owners towards cattle is one which is peculiar to this Colony; their interest stops at ownership or at the most is extended to the cows in milk. Individually, the peasants own few animals, collectively the number runs into thousands; but there are very few peasants sufficiently interested in stock to desire to make stock-keeping a means of livelihood. There is ample proof that the Colony is eminently suited for stock-raising, and, unfortunately, there is equally strong proof that this industry is not attractive to many of the population.

STOCK FARM.

The farm has been divided into paddocks. A cow stable designed to serve as a pattern for farmers interested in cow-keeping has been built. It is not a costly structure, and is cool and sanitary. Three portable pig-houses have been built; these are cool, easily cleaned and give the necessary protection against sun or rain. Poultry and pig runs have been erected, and a storehouse for foodstuffs has been built. A burnt earth road has been laid, Saman trees have been planted for shade, and Uba Cane has been grown for fodder.

PASTURE.

Apart from dividing the land into paddocks, it has not been possible to do anything to improve the pasture. This has not been a handicap in that it has been possible to make a practical test of the value of the natural herbage which is common in the coastal belt wherever the land is not overstocked. The trial shows that the pasture will maintain working oxen in good hard condition without supplementary feeding, but it is not good enough to produce prime condition in animals which are not working. Milch cows and young stock required supplementary rations for full milk yield and growth. Trials made of feeding elephant, para, and the mixed grasses of the Botanic Gardens gave unsatisfactory results. The best results were obtained with Demerara Primrose (*Asystasia scandens*). Demerara Primrose is grown as an ornamental plant in the Botanic Gardens. It grows luxuriantly on heavy soil wherever there is shade. It can be grazed or cut and fed. Dry cows grazed on primrose during the day and fed with

grass at night maintained excellent condition. Both cattle and pigs eat the plant greedily. It increases the milk flow of cows and sows. In sickness, when concentrates and grass have been refused, it has been invaluable. Young imported Canadian stock which had been stall fed and had probably never seen grass, at first refused the grasses fed to them but ate the primrose readily. It is the first green herbage eaten by calves. On the stock farm it is fed half and half with grass. This plant should be grown extensively in the coastal belt wherever there is the required shade. An analysis of the plant made by the Government Chemist-Ecologist corroborates its feeding value found in practice. That there is better pasture in certain areas of the coastal belt than that of the stock farm cannot be doubted. There are many well grown animals in various areas which prove this. The grasses found on the stock farm have been identified by the Government Botanist, and several of them have been analysed by the Chemist-Ecologist. In practice and by analysis they have proved to be lacking in phosphates, calcium and nitrogen with the single exception of the plant Demerara Primrose. General observation of animals in other parts of the coastal belt tends to make one believe that there are pastures which are not deficient. There may be grasses and plants of equal value to Demerara Primrose, and investigation on these lines will be made. Generally what is lacking throughout the coastal belt is quantity rather than quality.

Concentrates.—Locally grown foodstuffs which might be made up into balanced rations for cattle and pigs are difficult to obtain at prices which make them economic feeding. Imported foodstuffs although much cheaper than local produce are expensive. The Superintendent of the Onderneeming Industrial School has supplied a quantity of corn-meal to the stock farm, and the Superintendent of the Experiment Station has supplied mixed padi. These foodstuffs have been of value and have reduced the cost of feeding. Possibly farmers could grow and sell these foodstuffs at the prices at which they are valued by the Government institutions concerned. Useful data concerning foodstuffs which can be obtained in the Colony have been collected by visits to the stables of stock-keepers who manage their stock on intensive lines. The adjustment of the foodstuffs fed in these stables so as to make them balanced rations has invariably reduced the cost of feeding and increased the milk supply. The cost of feeding in outside stables before adjustment has always been higher than that on the stock farm.

Mineral Rations.— A mineral ration which is considered makes up the deficiency in the foodstuffs has been fed to all stock. The small number of animals has not allowed of controls by which animals fed with minerals could be compared with animals not receiving minerals, but the rate of growth of the young stock and the health and conditions of the animals and poultry generally on the farm have justified their use.

ANIMALS.

Donkeys.— The jack "Red Cloud" which was seriously ill at the end of last year became worse and eventually had to be destroyed. The results

of the post-mortem examination have been reported. The jack "Clay King" reported last year as being an unsatisfacfory stud animal has not improved. The jack "Tip Top" has given satisfactory service in various districts.

Cattle.— The Fresian cows "Regan" and "Rose" calved successfully. The calves have grown well and promise to be valuable bulls. The Fresian bulls "John" and "Bill" and the Holstein Zebu bull "Bruce" have been at stud in various districts. Two young Fresian bulls were imported from Canada. They are now acclimatized and one is at stud.

Pigs.— The litter of large black pigs farrowed at the end of last year, and the three large black sows have been sold to farmers. Two Berkshire sows and one Bershire boar were imported from Canada. One sow farrowed a litter of ten; nine were reared and sold to farmers. The second sow is due to farrow early next year. The boar is now at stud for selected pigs.

Poultry.— A pen of eight young white leghorn pullets and one cockerel were imported from Barbados. The pullets have been trapnested. They began to lay in September and produced 720 eggs by the end of the year. Eggs for setting will be sold next year.

ANIMAL HEALTH.

Compared with other stock-raising countries there are few contagious and infectious diseases of animals in the Colony.

Veterinary Clinics.—It was decided to establish centres in the country districts at which peasant stock-owners could register their names and addresses if they desired veterinary assistance or advice. The village offices were considered to be the most suitable centres at which to keep registers. For several months periodical visits were made to all districts, but no interest was shown by stock-owners. It was realised that peasant stock-owners were not interested in the welfare of their stock, and the clinics had to be suspended until the new District Agricultural Officers have had an opportunity of getting to work.

Anthrax.— A break-down in the immunity conferred by the single vaccine inoculation was reported to the manufacturers who recommended that a stronger vaccine, to be used together with serum, should be supplied by them. A supply was obtained as early as possible. The serum-vaccine inoculation is more expensive but in the circumstances there is no alternative. Two outbreaks of Anthrax occurred in the Mahaicony District. It is probable that the source of infection was the same for both outbreaks, the open savannah adjoining Plantation Farm. In theory it would have been ideal to have placed the whole of the savannah and the villages from which cattle are sent to the savannah under quarantine. It was realised, however, that it would not be possible to maintain the quarantine over such a large unenclosed area. The best that could be done was to quarantine the

places on which cattle died, and order the inoculation of the animals belonging to those places. The inoculation of the animals concerned with the first outbreak was carried out expeditiously; the owner of the land rendering all possible assistance. The inoculation of the animals belonging to the villagers of Plantation Farm, which was the second infected area, was carried out under difficulties and required the assistance of the police. In each outbreak only one animal was proved to have died of Anthrax, but it is probable that several animals which died suddenly before each outbreak was reported also died of Anthrax. The skinning and cutting up of animals which have died suddenly will have to be forbidden and the penalties for breach of the order will have to be heavy. Every opened anthrax carcase creates a new centre of infection. At the present time most of the cattle on the savannahs are of little value—until a prospective buyer appears, in their owner's opinion, they are not worth the cost of a dose of vaccine. If a cattle industry is to be established these poor types of cattle will have to be eliminated, and improved breeds take their place. The number of infected areas will then be a serious matter. Casualties amongst improved cattle will be heavy and the financial losses great. Countries to which cattle are exported may not accept consignment in which a case of Anthrax has occurred in transit. And if an outbreak occurs on landing, the whole consignment will be placed in quarantine. The export trade may be stopped or carried on only under certain restrictions.

This is, perhaps, a matter of little importance now, but may be of great importance in years to come. It is most urgent that all infected areas should be fenced, and that cattle inside these areas be inoculated with vaccine annually. The fencing of every grazing area in the coastal belt is a small matter compared with what is done in other countries. At the moment with one Public Road along which cattle can be driven there is nothing to prevent every grazing area becoming infected.

Anaplasmosis.—A blood disease transmitted by ticks. Blood smears taken from dead calves in the Essequibo district showed anaplasma. The calves were the progeny of imported sires and had been grazed on a pasture heavily infested with ticks. The recently imported Canadian bulls contracted the disease on the pasture of the stock farm, These animals were gradually exposed to infection and were kept under close observation. One showed signs of the disease on the 100th day and the second on the 116th.

The symptoms shown were dullness, fever, anaemia, and refusal of food. One showed intestinal disturbance. These animals were treated with Sodium Cacodylate and were convalescent after four weeks. It is probable that all imported animals will contract this disease. The results of the treatment obtained with the Canadian animals tend to make one believe that the disease in this Colony is not dangerous provided that the sick animal receives prompt attention.

It is interesting to record that the young creole bull "Bill" and the calf born this year have both gradually been exposed to infection on the stock farm pasture, and neither have shown any signs of sickness. Both are pure bred Fresian.

Internal Parasites.—There is reason to believe that many of the extremely emaciated animals seen on the savannahs are suffering from internal parasites. It is hoped that greater facilities for investigation will be obtained next year.

Stock Regulations.—A new Ordinance was compiled at the beginning of the year. Suggestions for safe-guarding the land frontiers against introduction of diseases by imported animals have been made.

TRAVELLING.

All the country districts were visited several times in connection with veterinary clinics. Several journeys were made to investigate suspected outbreaks ot contagious and infectious disease. An investigation of ranching problems of the intermediate savannahs was carried out in company with the Government Ecologist and Botanist. Weekly visits have been made to the Police stables, and at other times when required. Hides for export and animals for import have been inspected.

GENERAL.

The Government stock-farm should be a model one which farmers can visit so that they may see what improvements they should attempt on their own farms. At present an endeavour is being made to build a farm on the same amount of money as was previously allotted merely for the maintenance of the government live-stock, and the progress made is necessarily slow. To arouse an interest in live-stock, and it really needs arousing, there can be nothing better than a government stock-farm which can supply good foundation stock to farmers. Our present system of sending stud animals to the different districts is proving unsatisfactory. It entails considerable expense and very few stock owners apply for their services. An enquiry made as to the results of the stud bulls was disappointing. Donkeys receive more care than cattle in this Colony. The services of the stud donkeys are more freely used. The results are not so good as they might have been due to the owners putting these animals to work before they are mature. Many of the progeny of the stud jacks have been spoiled in this way. Cattle breeding and pig rearing instead of being minor neglected industries ought to be major industries. Export markets await them. The most expeditious way to improve the breed of cattle is to provide fixed centres for the stud animals, and in their neighbourhood provide reasonable facilities for the grazing of carefully selected female animals. A few graded herds here and there would attract attention and help to create an interest in cattle. The breeding of pure bred animals by the Government should be on a larger scale.

T. Bone,
Government Veterinary Surgeon.

BOTANIC GARDENS.

ANNUAL REPORT, 1929.

The following is my report on the working of the Botanic Gardens for the year ended December 31, 1929.

Ornamental Section :—Further progress in connection with the re-arrangement of the different shrubs in the Flower Gardens has been made during the year. The greater portion of the work, however, was pushed forward in the earlier months of the year. Operations were suspended later in the period under review, on account of the dry season which began during August and continued to mid-November.

The beds which have already been planted for mass effect begin with the one west of the Band Stand with Acalyphas. That on the eastern side of No. 1 Lake consists of white, and blue Petrea planted alternately. The beds on the southern side of the Band Stand and proceeding to the cherry hedge contain Scarlet Ixoras and Eranthemums respectively. The semi-circular beds, on which annuals were grown for floral display, have been planted with a permanent cultivation of Graptophyllum, while red-coloured Ixora plants occupied the circular bed in this section. The Graptophyllum has been selected for its decorative foliage, to contrast with the flowering of the red Ixora plants. Beyond, on the south-eastern section, there is a conspicuous mass of *Plumbago capensis*.

Along the Main Drive, the bed east of the scarlet Ixora plots gives a yellow effect with plants of *Galphimia glauca* predominating; in the next plot is a display of blue Duranta. Under the Attalea palms is planted *Thumbergia erecta*, and around the circular beds at the Main Drive are Poinsettias.

Along the semi-circular road to the southern portion of the Gardens, the following beds have been completed. On the first bed on the right is a fine display of a variety of Codiaeums, and pink Lagerstroemias on the second bed. The first bed on the left is planted with double pink Hibiscus, and in the succeeding bed are white Lagerstroemias, Gardenias, and Spiraea plants.

The border in the south-western section of the Gardens has been planted with alternating blocks of Lagerstroemias, of various colours, and Oleander plants.

The several beds were well-maintained during the year under cultural methods of forking and mulching. The parapets around the beds have been continuously under cultivation during the year with a variety of annuals.

Some interesting packets of seeds were received from Brignoles Botanic Station, France; these were for the most part ornamental plants and perennial herbs. The seeds were tried out on specially prepared plots to note what progress they

would make in these Gardens, but, unfortunately, the seedlings have not succeeded. Later in the year a consignment of 59 packets of seeds was received from the Harward Botanical Gardens, Soledad, Cuba. The consignment consisted of a variety of palm seeds and of flowering trees and shrubs. The majority of seeds was sown at the close of the year. Among the importations during the period under review were seeds of an interesting liliaceous plant—*Agapanthus umbellatus*—received from the Museum D'Histore Naturelle, France. The seedlings made a poor start, but, with a change of soil, have begun to show signs of more vigorous growth.

In December a collection of South African succulent plants was received from the University of Stellenbosch, South Africa. Unfortunately, the consignment was received at the wrong time of the year and their success at present seems somewhat doubtful.

Efforts during the year have been made to add to the collection of the palm cultivation of the Gardens in respect to new species, by means of exchange from abroad and by replacing those which have died. On the 2nd May two Double-coconuts (*Lodoicea callipyge*) were sown on No. 1 Island.

Park Lands:—This section of the Gardens was uniformly kept in good order during the year. Operations in connection with the eradication of the Antidesma bush, which in former years over-ran these lands, have made very satisfactory progress. A large portion of the Park Lands is now freed of this pest. Work in other parts of the Gardens, where the pest is prevalent, was in progress towards the latter part of the year. Plants of the scarlet Bougainvellea have been planted on the north section of these lands with a view to making this section of the Gardens more attractive from a floral point of view. The row of *Cassia javanica* on the eastern side of the second Nymphaea lily trench is making very good growth, but the *Cassia fistula* plants on the eastern side of the first Nymphaea lily trench are somewhat backward at present. The labels mentioned in last year's report have been received and arrangements are being made to affix them to the respective trees.

Lawns:—During the year progress in the improvement of other sections of the lawns has not made very rapid headway owing to the difficulty of obtaining material for renovation. The sections previously renovated have been well maintained during the period under review. Portions of lawns which were separated by small drains have been joined together in order to give a more extensive stretch of sward. The drainage of the roads has been provided for by means of underground pipes.

Roads:—During the year a large heap of earth was burnt for the purpose of repairing the roads. In view, however, of heavy motor traffic, burnt clay is proving too soft as road material; consequently, where the roads have been worn

into hollows and ruts, they have been patched with granite. Where practicable, the granite is covered with a layer of burnt earth, so as to maintain the attractive appearance of the Gardens.

Nurseries:—In the progress report for the period ended 30th June, 1929, mention was made of the pruning of the ornamental climbers and vines growing on the iron frame work of the houses. Owing to the rainy period these plants were growing into a mass of wild entanglement; they were, therefore, vigorously pruned to check the tendency of too luxuriant growth. Since the pruning operations they are growing into a better trained condition and are flowering profusely.

The following is a list of orchids which flowered during the year and the respective months of flowering.

IN THE NURSERY HOUSES.

NAMES OF ORCHIDS.	MONTHS OF FLOWERING.
Angraecum eburneum	November
Brassia Lawrenciana	February
Brassia caudata	February
Cattleya Jenmanii	November
„ *Mossiae*	December
„ *labiata var: speciosissima.*	February, July
„ *Skinneri*	April
„ *Bowringiana*	January, February, July, August, October, November
„ *labiata var: Gaskelliana*	February
Catasetum macrocarpum	June
Cymbidium pendulum.	February, May
Coryanthes macrantha.	August
Coelogyne pandurata	August
Diacrium bicornutum	January, November
Dendrobium chrysotoxum	March, June, December
„ *Pierardii*	April
„ *superbum*	July
„ *moschatum*	December
Epidendrum fragrans	January
„ *ciliare*	January, November
„ *osmanthum*	January
Gongora atropurpurea	July
„ *quinquenervis*	November
Maxillaria sp.	April
Miltonia spectabilis	June, August
Oncidium ampliatum	January, June, August
„ *Sprucei*	January
„ *altissimum*	August
Phalaenopsis Aphrodite	June

NAMES OF ORCHIDS	MONTHS OF FLOWERING.
Phalaenopsis Esmeralda	February, July, August
„ *amabilis*	February, July, August
„ *Stuartiana*	April
Renanthera coccinea	January, April
Rodriguezia secunda	April
Stanhopea eburnea	June
„ *Wardii*	December
Scuticaria Steelii	July

IN THE ALMOND GROVE.

Aerides crispum	March
„ *multiflorum*	May
Dendrobium moschatum	January
„ *nobile*	May
Epidendrum ciliare	June
Oncidium altissimum	March, July

Economic section:—This section has had a thorough renovation during the latter part of the year. The plant tables have been reconstructed and are now in good order and condition.

In the progress report for the period ended 30th June, it was mentioned that much progress was made with regard to the propagation of coffee and cacao and various fruit plants. Special attention has been given to the selection of seeds. A moderately large variety of fruit plants which were in stock at the close of the year has been carried forward to 1930 and their propagation has been continued.

Further budding operations continued during the year. Another shipment of budwood was received from the Department of Agriculture, Trinidad, in November. This consisted of "Marsh" seedless and "Duncan" grape fruit. Arrangements were being made at the close of the year in order to push ahead for mass production, and in this respect many thousands of seeds have been sown to raise stock seedlings for budding on in 1930, as budwood material becomes available.

The general activities of the Nurseries during the year are shown in the following table.

TABLE I.

No. of seeds sown	30,827
Seedlings basketed	12,639
Seedlings potted	1,070
Plants rebasketed	3,736
Plants repotted	1,558
Plants top-dressed	912
Plants tubbed	63

Plants divided	782
Plants ringed	809
Plants grafted	153
Plants budded	732
Cuttings planted in bed	3,948
Cuttings basketed	916

The sales of the economic section of the nurseries for the year 1929 are shown in the following table.

TABLE II.

Months	Liberian Coffee	Robusta Coffee	Cacao	Budded Citrus	Various Fruit Plants	Amount $	c.
January	2,000	...	...	9	216	37	67
February	212	...	...	14	68	10	73
March	108	...	...	10	170	8	72
April	2	...	...	37	185	18	28
May	1,561	...	...	3	140	28	00
June	60	...	...	3	86	4	24
July	737	...	704	2	263	26	71
August	174	...	113	9	109	10	54
September	12	...	512	6	28	10	84
October	24	...	12	18	110	9	88
November	4	900	...	3	213	19	10
December	200	...	...	7	176	9	26
Totals	5,094	900	1,341	121	1,764	$193	97

There has been a marked increase of sales to the extent of $110 over the sales of economic plants for the year 1928. In the following table is shown the distribution of the economic plants in the several districts for the year 1929.

TABLE III.

DESCRIPTION AND QUANTITIES OF PLANTS.

Destination	Coffee Plants						Cacao	Budded Citrus Plants				Papaw	Sour Sop	Sapodilla	Various Fruit Plants	Totals
	Arabian	Canephora	Excelsa	Liberian	Robusta	Stenophylla		Grape Fruit: Marsh	Grape Fruit: Duncan	Grape Fruit: Walters	Oranges: Various					
Experiment Stations:																
Hosorora, N.W.D. ..	...	...	250	450	...	120	...	125	56	5	67	...	...	...	18	1,091
Pomeroon	80	...	70	...	75	110	...	20	...	...	...	...	...	...	...	355
Districts:																
Berbice	...	...	...	...	900	...	...	20	...	...	...	...	...	...	...	920
North-West	...	...	...	...	...	...	600	24	...	...	5	..	...	12	37	678
Essequebo	...	125	...	1,400	125	56	300	14	...	...	2	4	2	11	38	2,077
Demerara E.C. ..	...	...	...	242	...	...	138	37	...	...	..	320	3	102	200	1,042
Demerara, R. ...	...	...	100	1,424	100	...	40	6	..	...	...	124	239	158	386	2,577
Pomeroon R. ...	...	...	...	1,159	...	...	500	6	...	...	15	13	...	...	69	1,762
TOTALS	80	125	420	4,675	1,200	286	1,578	252	56	5	89	461	244	283	748	10,502

The following table gives the receipts for the year 1929.

TABLE IV.

Item.	*Amounts.*
Plants	$474.13
Flowers	26.92
Seeds	3.47
Bamboo	38.26
Pots	26.92
Hire of Plants	14.88

Government House and other Gardens and Grounds:—The cultivation of the parapets around the borders was maintained during the year with a variety of annuals. The general routine of work was carried out both at Government House Garden and at the Grounds of the Public Buildings in keeping the plots in good order and condition.

Interchange of Seeds and Plants:—The interchange of seeds and plants with other Departments of Agriculture and horticulturists was maintained during the year. The contributors to these Gardens were as follows:—

Name of Departments, etc.	*Description of Seeds or Plants.*
Agricultural Department, Dominica.	Seeds of *Coffea arabica* and of *Coffea stenophylla*
Henry A. Dreer, Philadelphia.	Flower seeds (var.)
Brignoles Botanic Station, Brignoles, France.	Seeds of ornamental shrubs.
Museum D'Histoire, Naturelle, 61 Rue de Buffon.	Seeds of *Agapanthus umbellatus.*
Curator of Botanical Garden, University of Stellenbosch, South Africa.	A collection of South African succulent plants.
Botanic Gardens, Singapore, Straits Settlements.	Palm seeds :—*Actinorhytis calapparia, Oncosperma horrida* ; *Ptychoraphis singaporensis.*
G. A. Caleb, Nigeria	Shea Nuts.
Department of Agriculture, Manilla, Philippine Is.	*Griffithianthus Merrilli*
Department of Agriculture, Dar-es-Salaam.	Seeds of miscellaneous trees.
Director, Ministry of Agriculture, Giza, Egypt.	Seeds of Cupressus, Aristolochias, Barberia, Oenothera.
Harward Botanical Gardens, Soledad, Cuba.	57 packets seeds of Palms, shrubs and trees,
Director, Horticultural Division, Botanic Gardens, Lithuania.	Bulbs of *Agapanthus umbellatus.*
Department of Agriculture, Trinidad.	Budded avocado pears, Grafted Mangoes.

The contributions sent abroad from these Botanic Gardens during the year are as follows:

Recipients.	*Contributions.*
Botanic Gardens, Trinidad.	*Victoria regia* seeds, Lotus lily seeds.
Director of Agriculture, Ceylon.	*Passiflora lauriflora.*
Director, Botanic Station, Brignoles, France.	Palm seeds.
Institute of Applied Botany, Leningrad, Russia.	*Luffa acutangula, Luffa cylindrica*
United States Department of Agriculture, Washington, U.S.A.	Palm seeds.
Curator, Botanic Station, University of Stellenbosch, South Africa.	*Hippomane Mancinella*
Director, Department of Agriculture, Dar-es-salaam, East Africa.	Palm seeds.
Director, Ministry of Agriculture, Giza, Egypt.	*Bignonia gracilis.*
Department of Agriculture, Division of Horticulture, Abrui, Gold Coast.	Palm seeds.

A. A. ABRAHAM,
Asst. Supt., Botanic Gardens.

METEOROLOGY.

ANNUAL REPORT, 1929.

The following are abstracts from the meteorological observations recorded at the Botanic Gardens, Georgetown, and at the Penal Settlement, Mazaruni, during 1929.

Meridian of longitude for calculation of time adopted as standard in the Colony	...	...	60°W.
Hours slow of Greenwich time	...	...	3.45

GEORGETOWN.

The meteorological station is situated in the Botanic Gardens at a distance of 1.45 miles south of the coast-line. The hours of observation are 7 a.m., and 1 and 6 p.m., local official time, which is 3.45 hours behind Greenwich time. The height of the barometer is 6 feet 6 inches above the mean sea-level.

During the year 1929, the air temperature in the shade for the months of January, March, June, July and December, was lower than the means recorded over the period 1846–1928. The highest temperature recorded was 90.0°F. on the 18th October, while the lowest was 70.0°F. on the night of October 20th. The mean shade temperature for the year was 80.1°F. or 0.3° lower than the average from 1846–1928. The total rainfall was 71.62 inches, as compared with 96.48 inches in the year 1928 and with 88.64 inches for the period 1880–1928. The total rainfall, from January to April inclusive, was 19.23 inches as compared with 34.19 inches in 1928. Heavy rains were experienced in the months of May and June. For the months of July to December inclusive, the total rainfall was 27.14 inches or 13.33 inches below normal. The evaporation from a free water surface, a six ft. square tank at the ground level, was 61.98 inches as compared with a normal evaporation of 57.90 inches; the evaporation for 1928 being 86.54% of the total rainfall. The total amount of bright sunshine for the year was 2474.4 hours as compared with 2461.6 hours in 1928 and with 2364.5 hours in 1927 and was 16.7 hours above the average from 1846–1928. The mean radiation temperature (blackened bulb in vacuo) was 5° higher than normal and 0.7° higher than that of the previous year, the maximum monthly record during the year being 151.9° for October, while the highest daily record 159.0° occurred on the 10th October. The mean minimum temperature on grass was 0.7° higher than the average. The mean velocity of wind was 7.08 miles per hour, the maximum velocity being 18.75 miles per hour. The anemograph recorded a gale travelling at the rate of 39 miles per hour at 2.50 p.m. on Friday, 5th July. There was an earth tremor at midnight on 19th October.

MAZARUNI.

A sub-station established at the Penal Settlement, Mazaruni River, is in longitude 58° 38′ 45″W. and latitude 6° 23′ 35″N: at a distance of 42 miles south of the coast-line. The hours of observation are the same as at the main station in Georgetown. The height of the Barometer is 55 feet above mean sea-level.

During 1929 the mean air temperature in the shade was 77.8°F; the maximum temperature recorded being 91.0° on the 23rd September, while the minimum, 69°, occurred on January 18th and 27th as well as on 5 nights in February, 2 in March, 2 in April and 3 in December. The total rainfall was 98.5 inches or 2.05 inches higher than that of the previous year. The general distribution of the rainfall was far in excess of that in Georgetown, except that during the month of February 1.62 inch less of rain fell at Mazaruni than in Georgetown. The total rainfall for the year was 26.96 inches higher than that at Georgetown. Rain fell on 232 days in the year as compared with 196 in Georgetown. The total amount of bright sunshine recorded during the year was 1,847.8 hours as compared with 2,474.4 hours at Georgetown.

RAINFALL.

The mean annual rainfalls of the three counties, maximum and minimum rainfall recorded in any year, and the maximum rainfall recorded in any month are compared in the following :—

Rainfall in inches.

YEARLY.

	Berbice.	Demerara.	Essequebo.
1910–1920 ...	80.98	92.33	100.87
1921 ...	84.04	112.95	135.91
1922 ...	87.54	106.46	136.13
1923 ...	72.52	83.02	89.02
1924 ...	75.41	84.87	91.23
1925 ...	51.77	63.09	73.95
1926 ...	63.49	75.45	89.89
1927 ...	117.43	117.75	137.36
1928 ...	84.33	99.17	102.63
1929 ...	68.19	81.38	92.66

Maximum and Minimum Rainfall recorded in any year.

Maximum ...	144.31	161.46	193.89
Minimum ...	40.19	34.99	41.79

Maximum and Minimum Rainfall recorded in any month.

Maximum ...	29.31	46.88	34.85
Minimum ...	Nil.	Nil.	Nil.

EXPORTS OF AGRICULTURAL AND FOREST PRODUCTS.

Below will be found a list of the Agricultural and Forest Products of the Colony exported during the first nine months of 1930.

The corresponding figures for the same period during previous years and the average for the twelve years prior to that are added for convenience of comparison.

Product		*Average 1916-27*	*1928*	*1929*	*1930*
Sugar	tons	57,017	71,022	49,947	66,343
Rum	proof gallons	1,496,200	1,111,463	891,685	625,661
Molasses	gallons	315,256	1,855,803	1,979,394	2,293,268
Molascuit	tons	872	1,121	1,083	350
Rice	tons	5,861	13,148	9,311	16,651
Coconuts	thousands	1,444	217	435	337,415
Coconut Oil	gallons	15,856	20,765	13,300	16,670
Copra	cwts.	6,830	38,952	58,769	32,905
Coffee	cwts.	4,310	6,802	8,049	1,198
Lime Juice Concentrated	gallons	5,146	5,566	10,275	None
Essential Oil of Limes	gallons	223	314	645	434
Rubber	cwts.	92	143	15	46
Balata	cwts.	4,629	3,658	2,293	2,585
Gums	lbs.	1,708	1,674	None	787
Firewood—Wallaba, etc.	tons	5,752	7,839	7,192	8,413
Charcoal	bags	32,969	34,370	37,612	39,603
Railway sleepers	No.	12,544	13,682	10,721	3,375
Shingles	thousands	1,474	1,402	1,799	1,208,250
Lumber	ft.	144,926	115,542	82,726	99,622
Timber	cu. ft.	106,203	122,876	262,267	142,370
Cattle	Head	287	412	466	1,305
Hides	No.	5,382	5,721	5,133	5,434
Pigs	No.	305	426	271	672
Sheep	No.	25	2	None	4

CURRENT PRICES OF COLONIAL PRODUCE.

From The Commercial Review, Journal of the Georgetown Chamber of Commerce, Vol. XIV, No. 5, November, 1930.

SUGAR.

Per 100 lbs. net 3 lbs. per Bag allowed for tare

Dark Crystals for Local Consumption..................$2.80
Yellow Crystals do. do. $3.50
White Crystals...$4.25 to $4.35
Molasses Sugar...... ....none offering

RUM.

Imperial Gallon. Cask included.

Coloured, in Puncheons—40 to 42 O.P...(for export).....60c. Hhds. 65c. Barrels 70c.
White, in Hogsheads—10 to 45 O.P....(for local consumption)............48 to 55c.

MOLASSES.

Per Imperial Gallon. Cask included.

Yellow (firsts).. }
Yellow (seconds).. } None Offering
Dark.. }

RICE.

Rice............per Bag of 180 lbs. gross, $3.00 to $5.00 as to quality.
Paddy..........per Bag of 143 lbs. gross, 50c.

GENERAL.

Timber, Gr. Heart, (Lower grade measurements)...72c. to 96c. per c. ft., for export $1.00 to $1.20 per c. ft.
Do. Railroad Sleepers—(Mora)..$1.68 each
Greenheart Lumber..$110 per 1,000 feet
Crabwood Lumber..................... ....$60 to $75 per 1,000 feet
Shingles, Wallaba, 4 x 20 and 5 x 22 inches,......................$7.00 to $9.00 per M.
Charcoal, Capped for shipment..$1.00 to $1.20 per Bag
Firewood............ ....$3.00 to $3.50 per ton
Coconuts.........Selects, $18.00, culls......$10.00 M.................Copra, 3½c. per lb.
Balata................. . ...Venezuelan, none. Local Sheet...38 to 40 cts. per lb.
Cocoa.......... ....14c. „ „
Coffee...5c. „ „

N.B.—Duty payable on value at time of Importation and at Rate of Exchange on day of arrival.

METEOROLOGICAL DATA—JULY—SEPTEMBER, 1930.

Recording Stations & Months.	Rain-fall. Total Inches.	Number of Days of Rain: Under ·10 Inch	·10 to ·50 Inch	·50 to 1.00 Inch	1.00 Inch to 2.00 Inches	Above 2.00 Inches	Total days.	Evapo-ration. Inches	Air Temperature and Humidity: Air Temp. Maximum.	Minimum.	Mean	Humidity. Mean
Botanic Gardens.												
July ...	21.02	5	7	6	4	3	25	3·61	84·1	75·2	79·6	85·0
August ...	4·59	1	4	2	2	...	9	6·17	86·1	75·8	80·9	80·9
September ...	·62	2	2	...	...	...	4	7·28	87·9	76·2	82·0	78·1
Totals	26·23	8	13	8	6	3	38	17·06				
Means.	...	...	...	...	...	...	...	...	86·0	75·7	80·8	81·3
Berbice Gardens.												
July ...	19·46	2	9	4	5	2	22	...	87·4	74·9	81·1	81·6
August ..	2·44	4	2	1	1	...	8	...	89·3	75·7	82·5	77·7
September ...	·81	...	1	1	...	...	2	...	90·2	75·8	83·0	76·5
Totals	22·71	6	12	6	6	2	32	...				
Means.	...	...	...	...	...	...	...	...	88·9	75·5	82·2	78·6
Onderneeming.												
July ...	18·52	...	11	4	3	3	21	...	87·2	74·4	80·8	83·5
August ...	2.08	...	6	...	1	...	7	...	88·1	74·8	81·4	82·4
September ...	·34	...	2	...	...	...	2	...	87·9	75·5	81·7	84·0
Totals	20 94	..	19	4	4	3	30	...				
Means.	...	...	...	...	...	...	...	...	87·7	74·9	81·3	83·3
Morawhanna, N.W.D.												
July ...	16·11	4	9	8	1	3	25	...	...	...	...	...
August ...	4·59	2	7	3	1	...	13	...	...	...	...	...
September ...	7·11	...	6	4	1	1	12	...	...	...	...	...
Totals	27·81	6	22	15	3	4	50	...	...	...	...	...

INDEX TO VOL. III

1930

A

D

Page

E

F

G

H

I

P

S

T

U

V

W

THE AGRICULTURAL JOURNAL OF BRITISH GUIANA

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In collaboration with the Officers of the Department of Agriculture.

CONTENTS.

(VOL. IV, No. 1.)

ORIGINAL ARTICLES.

LIST OF ILLUSTRATIONS.

The

Agricultural Journal of British Guiana.

March, 1931.

EDITORIAL.

AGRICULTURAL PROGRESS.

"'*The time has come,' the Walrus said*
'*To talk of many things*'—"

This is the first number of the Agricultural Journal to be printed in 1931. It appears to be characteristic of persons and of institutions to consider their ways on these occasions which draw attention to the artificial demarcations of time. Moreover, the agricultural matters of British Guiana obtained such publicity during the last year, that it devolves upon this Department, as a duty, to present a concise and considered review on the present agricultural situation.

During 1930 economic depression has been world-wide and in British Guiana this depression has been felt, and felt severely. Seven years previously the Colony had balanced its budget; the diamond industry flourished mightily, balata to the value of well over half a million dollars was exported; the sugar industry then, as now, was the most important in the Colony, had very largely recovered from the 1920–21 slump (which had resulted directly from inflated war prices) and a profitable market for the product was assured. The erection of sea defences, which had been completed some years before on the East and West Coasts, Demerara, had put substantial sums of money into local circulation, while contracts for the installation of a modern sewerage system in Georgetown had already been awarded.

Reference to the Administration Reports shows that for the year (1923) there were decreases in the production of sugar, of rice, of coconuts, of coffee, of rubber and of ground provisions, *i.e.*, of all the important agricultural commodities. This need not, however, have been a matter for grave concern since the market conditions were such as to induce the agriculturist to regard with equanimity small reductions

in output. Auxiliary employment was to be obtained of so lucrative a nature as to encourage the farmer-labourer to consider seriously and with composure the suspension, if not the abandonment, of his agricultural activities.

The conditions obtaining in 1930 were markedly dissimilar, the unsatisfactory state of the world's markets being almost entirely responsible. The Colony's expenditure exceeded its revenue; there was a partial collapse of the diamond industry; the balata exports were reduced approximately by half; the sums put into local circulation from development schemes were almost negligible; sugar, with other agricultural products, was marketed under circumstances that were controlled by the sternest competition.

From these economic vicissitudes there has resulted a slow but unmistakable "back to the land" movement—an outcome of no little significance. That this consequence should have resulted seemed not only probable but inevitable, and Government, in 1928, established a reorganised Department of Agriculture on lines laid down by the Director of Agriculture (See *Sessional Paper No. 16A.*).

The important innovations and developments in the reorganisation scheme were :—

1. That the techinal operations of the Sugar Experiment Station should be directly under the control of the Director of Agriculture with the fullest collaboration of the staff of his Department and that an officer with experience in cane breeding and field experimentation should be appointed. Since then, varietal, manurial and cultural experiments have been laid down in all of the sugar producing districts of the Colony. Conclusions from some of the first series of these experiments are published in this number. It is significant that the interest taken in this work by commercial concerns has led to an offer, by one of the sugar producing combines, to pay the salary of a trained scientific worker who will be attached to the Department of Agriculture and who will co-operate in the investigations undertaken. Estate staffs have also co-operated closely in these endeavours.

2. That the Rice Experiment Station should be organised to proceed, with the utmost despatch, to produce, by selection, a uniform type of seed padi and to supply this selected seed cheaply to farmers throughout the Colony. Such measures were designed to lead, in due course, to the inauguration of a grading system, which is now in operation, under the control of the Department. Other developments have followed and help for this industry from the Colonial Development Fund is noted in another part of this issue.

3. That an experienced officer should be appointed as a whole-time Government Veterinary Surgeon and that pedigree stock should be imported with a view to establishing a live stock industry on the scale which local

conditions indicate should be possible. The importance of a Government Stock Farm, which would aid materially in improving the breeds of animals in the Colony, was stressed, and it was even recommended by the Director of Agriculture that a loan should be obtained for establishing such a Farm. The forthcoming visit of Mr. R. E. Montgommery, M.R.C.V.S., Adviser on Animal Health to the Secretary of State for the Colonies, is expected to lead to some definite progress in this direction.

4. That there should be, in the important agricultural centres of the Colony, a limited number of district agricultural officers who possess an agricultural training such as to permit them to conduct field experiments and to be able statistically to examine the results obtained. These officers are thus advantageously situated to stimulate agricultural development and to perform the extension work which in every country has been found so necessary for agricultural progress.

   The cane experiments carried out on outlying estates are immediately under the supervision of these district agricultural officers, as are the varietal trials with rice carried out on the Corentyne and in Essequibo, the coffee, citrus and poison plant experiments in the North Western District, the Colonization Settlement at Bush Lot, and the co-operative credit banks throughout the Colony.

To the advantages which are to be expected from this organisation to investigate systematically the Colony's chief agricultural problems it is not intended to refer, for it should be noted that it is typical of agricultural endeavour that so long a period must, of necessity, ensue between the realisation of the significance of achievement by the agricultural worker and the demonstration on an industrial scale of the value of such achievement that the layman has become prone to view extensive scientific experiments with scepticism if not with apprehension. Nevertheless there are certain recent phases of local agricultural development which cannot but give rise to profound satisfaction.

More sugar was produced in the Colony in 1930 than in any previous year although more than one plantation, unable to survive the keen competiton in prices, went out of cultivation; the average yield of sugar per acre has steadily increased and was the highest recorded in 1930—approximately 2½ tons sugar per acre. Results obtained with the standardisation of Demerara Rice have been beyond expectations and today the higher grades of this commodity are equal if not superior to unpolished rice produced in any country of the world; in 1930 the export figures for rice were greater than in any previous year and a most reassuring circumstance is that the number of countries, from which trade enquires have been lately received with regard to this product, has steadily increased as a result of the extensive marketing propaganda undertaken by the Department. The cattle ex-

port trade, which is in its incipiency, has been maintained and the steady local demand for the purchase of pedigree animals and fowls suggests that there is an awakening interest in the livestock industries. Extension in the coconut industry has progressed in recent years with dramatic rapidity and the erection, by a local firm, of a modern oil extracting plant which is producing a high grade edible oil from local nuts, may be expected to affect the industry favourably.

Such have the agriculturists of the Colony accomplished during a period of acute economic stress. It is well that the Department of Agriculture should have organised itself to co-operate in and lead this movement.

ORIGINAL ARTICLES.

FENCING AND ITS SIGNIFICANCE IN RELATION TO LOCAL LIVESTOCK PROBLEMS

BY

ANDREW M. FULTON, M.R.C.V.S., B.V.Sc., D.V.H.

During the past year or eighteen months slightly more interest has been taken in livestock activities in the colony, and there is a general realisation that we are not doing all we might to improve the quality of our animals. At the present moment, meat is one of the few commodities that is not suffering from the world-wide evil of over-production and the possibilities of this colony, as a stock-raising country, merit the livestock industry being taken a little more seriously than at present.

The standard of milk and beef production is distinctly poor and until we improve the quality of our slaughter animals, we shall always experience a difficulty in finding outside customers for them. What are the main essentials for improvement? Bulls and barbed wire! It is generally known that all the big meat exporting countries such as the Argentine and Australia have improved their herds by the importation of male animals, generally from England, but the attitude throughout the colony to the question of fencing and pasturage is a most peculiar one and it does not seem to be realised that the improvement of stock without fencing is almost an impossibility.

One sees, on the pastures, cattle, sheep, goats and pigs crowded on to unfenced and undrained land and in many cases the grazing is entirely free; the owner does nothing to improve his land or reserve it for his own animals, nor does he derive any income from the mixed collection of animals which wander over it. Many of the peasant class get free grazing for their animals which from the point of view of stock improvement is unfortunate. What a man gets for nothing he does not value so highly as that for which he has to pay. If more of the pastures were fenced and a reasonable charge to cover rent and fencing costs made for each animal, the more unprofitable ones would disappear. Thus by a type of economic elimination the better animals only would remain and breeding would take place from then only. Undoubtedly the large amount of free and semi-free grazing is responsible for the rearing up of much poor grade stock which would be better slaughtered. While land on the coast is worth generally between five and ten dollars an acre annually for rice growing, the same land used as a common pasture

often brings in no revenue to its owners. One would almost be justified in saying that stock is so second-rate here because there is so much land. At least few people take any care of pastures which are mostly unfenced, undrained, unmanured and unweeded—so much so that fair pasturage is sometimes allowed to revert to black sage bush.

Fenced Pastures For Working Mules.

Nor are the sugar estates blameless in this respect for few of them have fenced-in areas which may be reserved for their mules alone. Many of the mules, except when they are driven aback to abandoned land, share their grazing with cattle, sheep, goats and pigs, with the result that even out of the grinding season their grazing must be augmented with grass and cane top, stall fed. A mule pasture, fenced pig and goat tight, would result in considerable feeding economies, especially so when it is remembered that a mule may be left out day and night when he is safe inside a ring fence. There is nothing like 24 hour grazing to put mules in good condition, and if the pasturage is fair they need nothing else so long as they are not working. Many of the estates maintain that they are short of land and consequently cannot spare the acreage for a mule pasture, but if they would examine the situation more carefully, they would perceive that it is on such estates that fencing is doubly needed, in order to save for their mules something from the hoard of hungry animals which eat down a blade of grass almost as soon as it appears.

Manuring of Pastures.

Another disadvantage of unfenced pasturage lies in the uselessness of manuring land which has to be shared with other stockowners. No work on the manuring of pasture lands appears to have been done locally, but as much of our soil is known to be lime and phosphorous deficient, it seems probable that dressings of lime and slag, such as are applied to poor pastures in the United Kingdom, would prove economically sound here just as they do there. Wonderful results have followed the judicious manuring of heath, hill, mossy and scrub pastures in parts of England and they have been brought up to a rental value of from one to two pounds an acre. Within a few miles of Georgetown where cattle are kept for milking purposes and on sugar estates where working animals have to be fed, manuring should prove a sound economic proposition, but it is doubtful if at the moment, with present stock, it would pay for itself on ranching lands.

Disease Control Difficult Without Fences.

The control of animal diseases, and particularly of parasitic disease, calls for some system of fencing whereby pastures can be rested to free them of parasites or isolated when occasion demands. Fortunately, we are very free from epidemic animal diseases in this colony, but our stock do suffer to some extent from internal parasites, particularly those groups of nematode worms known as stomach and lung worms. Cattle and sheep are widely infected with the former and many of

the wasted and emaciated animals one sees owe their condition, not to tuberculosis as might be imagined, but to the presence of stomach worms. The eggs of these worms pass out in the faeces and infect the pastures so that the young stock in turn become infected. In England where a pasture becomes so infected with these worms peculiar to cattle and sheep, it is customary either to rest the land altogether, to mow it for hay or to graze it only with horses. Alternately, where the infection is with a horse parasite the land may be grazed with cattle or sheep, and finding no suitable hosts, in time the parasite dies out. Locally, pasturage is *never* rested so that parasites and their larvae can always find a host on which, or in which, to fulfil their life history, and such will always be the position until it becomes customary to fence land.

Reverting of Pastures to Bush.

A further indication as to how little interest is taken in pasturage is seen in the fact that very fair pasture land is often allowed to go back into bush. If land is in rice, a man will spend hours on end weeding out each individual grass plant from between the rice, but how rarely does one see a man going round a pasture topping off the black sage bushes when they are young and easy to keep under control. On some of the sugar estates good bahama grass pasture, to which the mules are particularly partial, has been taken over completely by bush, whereas had it had a half-yearly weeding, the price of one bag of oats would have paid for cleaning up quite a large area. By no means is it universally recognised that grazing is the cheapest form of feeding and that a grazing animal cuts its own grass and replaces the manure on the land.

Revision of Pounding and Fencing Laws.

The increasing interest in livestock has also brought to light the fact that there is room for much revision and addition in those laws relating to fencing, damage to crops by animals and impounding. At present the stockowner may be the victim of much injustice and be quite at the mercy of neighbouring cultivators of land. Livestock straying on to cultivated land may be impounded and the unfortunate pig may be shot; animals are frequently impounded when the owner is in no way to blame and when, furthermore, the blame actually lies with the person on to whose land they have strayed. It is sufficient for a person taking animals to a pound to state that they were straying on his cultivation, he leaves the animals and is presented, in the case of cattle, with two shillings per head, a payment which provides a settled income for some scores of men throughout the colony.

Cultivated land and pasture land frequently lie side by side with no fencing whatsoever in between and this is the cause of endless trouble, village feuds and foolish litigation. Obviously, either the stockowner or the cultivator or both should fence or there should be some agreement as to party fences. Not only might trouble be avoided but the waste of labour in which a grown man spends all day

in "cowminding" might be very materially diminished. A very fair method would be to put the onus for fencing on the stockowner where most of the land is in cultivation, on the cultivator where most of the land is in pasturage and to have party fences where there is a more or less equal division of pasturage and cultivation.

At present it is possible for a man to plant two acres of rice alongside three hundred acres of recognised pasture land, put up two strands of wire on walking-stick posts and then sit down and draw a comfortable income from the impounding of cattle which *must* stray on to his land. This condition of things is most unfair and although the case cited is an exaggeration it does sometimes happen that cattle deliberately are allowed to stray or even are driven on to a poor rice cultivation, so that some compensation for a poor rice crop may be found in the collection of pound fees. In brief, while the cultivator can find redress for the damage of his cultivation whether he is at fault or not, the stockowner can find little redress for the impounding of his stock, even though he be entirely blameless.

DESIRABILITY OF PERMANENT FENCING.

It is a pity that so few fences are of a permanent type and that when wire is put up a growing fence is not planted alongside as is so often done in England. In all fairness, no wire fence will last so long here as in a temperate climate and quite apart from the fact that many local fences are more faith than fence, the rotting of the posts, the using of nails instead of staples, the stealing of wire and the cheerful and irresponsible habit of burning rice straw against the posts, all go to make the life of a fence a very short one. While it is a yearly job in England to do a little hedging, fencing and ditching each winter, many proprietors here do not worry to look their fences over periodically with the result that when a few posts are down, the wire rapidly disappears and when next the question of a fence arises, an almost completely new one is required. Put bluntly, the stealing of wire and posts is by no means uncommon and in times of drought when grass is scarce fences are occasionally cut and outside cattle driven on to fenced enclosures. These are offences to be punished severely for, quite apart from the damage done, no man can pursue a breeding programme if his cattle are liable at any time to be mixed with a mob of "scrub" animals. In English law, cases are frequent of owners receiving substantial damages for pedigree heifers put in calf by wandering and straying "scrub" bulls.

THE COMPANY PATH.

A somewhat peculiar situation is sometimes found where a right of way exists right into the heart of a proprietor's land—"the Company Path". When different owners occupied first, second and third depths of land, a right of way existed by means of the Company Path and in spite of the fact that the one proprietor may now own all the depths on either side of such a right of way, the right of way may still exist as such. This means that persons may penetrate into the heart of an owner's land, having no legitimate business there and yet he is

unable to keep them out or summon them for trespass. The possibilities of such a situation are many and undoubtedly the position will have to be reviewed by Government who own the Company Path. The position further complicates the matter of fencing for if there be different proprietors on either side of the Company Path, either one must fence which is unfair, both must fence which is wasteful, or a party fence is not possible because it cannot be placed on any boundary line between their two holdings.

Unused Back Lands.

On the East Coast of Demerara there must be much land up against the Conservancy which might be used profitably for cattle grazing. It is on the East Coast where the front lands are particularly heavily grazed, the fencing and utilisation of these back lands would relieve the congestion in front. Growing stock, fattening steers and in-calf heifers should do well on these lands, for unlike milking cows, they do not need to be brought in daily. The fences would have to be of a permanent type and would be fairly expensive, soft wood posts and three strands of wire would not meet the case, but good sound fencing would soon pay for itself and obviate any danger of cattle destroying the adjoining cultivation.

Poor Pasture Causes Vicious Cycle.

Some of the suggestions in this article might appear to press somewhat hardly on the peasant and the small man, but from a wide viewpoint it must be realised that any measure which tends to make the rearing of poor stock unprofitable is desirable for the well being of the colony as a whole. To a certain extent there is a vicious cycle in the relationship of poor stock to poor pasturage, for with poor stock one cannot afford to improve pasturage, and with poor pasturage one cannot rear good stock. At the same time, while the judicious improvement of pasture by fencing, weeding and draining will necessitate each head of stock carrying a larger annual charge, the very increase in this charge will drive the unthrifty and unprofitable animals away and selective breeding will become more or less automatic. The poor animals are not weeded out when grazing costs nothing per year, but the suggestions outlined should result in better but fewer animals reaching maturity at an earlier age, giving calves at shorter intervals, yielding more milk and making better carcases of beef.

In conclusion it must be realised that the establishment of permanent fencing is a very good investment and that it will save much of the losses of damaged cultivations, injured cattle, expenses of impounding and stray catching, man-power used in "cowminding" and to a minor extent, time and money spent in courts of law.

MANURIAL EXPERIMENTS WITH SUGAR CANE. 1

BY

C. HOLMAN B. WILLIAMS, D.I.C.T.A.,

Sugar Cane Agronomist, Department of Agriculture, British Guiana.

INTRODUCTION.

In the experiments here described the canes were grown, in each case, on beds 37 feet wide separated from each other by open drains 2 to 3 feet deep. The canes were planted across the beds in continuous rows, 6 feet apart at Uitvlugt and 5 feet apart at Sophia. Each plot consisted of a definite number of rows (on one bed) of which the two outermost were discarded at the time of reaping. The dose of manure for each row was weighed out into a separate bag and applied on the surface near the canes. At reaping, the canes of each plot were reaped and weighed separately *in situ* with the aid of portable balances suspended from tripods. A representative sample of 50 lb. of cane from each plot was crushed in the experimental mills at the Sophia Station and the juice analysed by the Chemical Division of the Department of Agriculture.

I. UITVLUGT (FIELD 14 E.)

This experiment was designed primarily to determine what advantages, if any were to be gained by using fish manure (H.O.P. No. 1 and H.O.P. No. 2 A, as supplied by the Humber Fishing and Fish Manure Co., Ltd., of Hull, England,) instead of sulphate of ammonia as a fertilizer for cane. The experiment was carried out at Plantation Uitvlugt, West Coast, Demerara, where, in recent years, considerable quantities of these fish manures have been used.

The composition of average samples of these manures was as follows :

	H.O.P. No. 1	...	H.O.P. No. 2 A
Total Nitrogen ...	4.93 per cent.	...	4.30 per cent.
Total Phosphoric anhydride	8.68 ,, ,,	...	5.49 ,, ,,
Total Potash ...		...	10.42 ,, ,,

THE EXPERIMENT.

The experiment was made upon second ratoons of D. 625 in field 14 East. The soil was sampled and the samples submitted to the Chemical Division, Department of Agriculture, which reports as follows :—

	Topsoil. Markedly acid heavy silt.	*Subsoil.* Markedly acid clay, somewhat less acid than the topsoil.
Moisture at point of stickiness ...	41.7 per cent. ...	48.0 per cent.
Sand	9.8 " "	3.5
Index of texture ...	40	47
Normal pH	4.8	5.3
Exchange pH ...	3.9	4.4
Available potash ...	0.0069 per cent.	0.0057 per cent.
" phosphate ...	0.0407 " " ...	0.0114 " "
Organic matter ...	1.39 " " ...	0.671 " "

Judging from the results of experiments executed by Harrison and his colleagues* in this Colony, one would not expect this soil to respond to dressings of either potassic or phosphatic manures.

As plant cane the field had yielded over four tons of sugar per acre and as first ratoons the yield was just under four tons. The first ratoons were reaped in mid-February, 1930, and the manures were all applied on May 28 and 29, seven formulae being used. The experiment was of the 'randomised block' type, with five blocks. There were thus five plots of each treatment and the area of each plot reaped was 0.06115 acre. The field received the cultural treatment usually accorded by the Estate to fields of its class and the plots were reaped and weighed on February 5-7, 1931.

The following table shows the average distribution of the rainfall at Uitvlugt and that during the growth period of the canes :

	Rainfall 1930-1931. inches	Average Rainfall 1916-1930. inches
February, 1930 ..	5.30 ..	3.98
March .	1.95 ..	4.60
April ...	8.77 ...	5.14
May	12.86 ...	13.63
June	12.97 ...	13.96
July	22.67 ...	11.91
August	5.68 ...	8.12
September	2.93 ...	3.53
October	1.39 ...	3.77
November	2.49 ...	7.95
December	9.59 ...	13.87
January, 1931 ...	4.55 ...	9.02
Total	91.15	99.48

* HARRISON, STOCKDALE & WARD: *West Indian Bulletin*, XIII, p. 176.

Samples of cane were collected and analysed as explained in the introduction above. Through the courtesy of the Estate authorities it has been possible to obtain the actual yield of the field in terms of 96° sugar, and the purity of the juice expressed by the factory mill. Since the Sophia laboratory mill only expresses 55-60 per cent. of the juice from the cane, as compared with 75-80 per cent. for the factory mill, the figures, as will be seen below, differ somewhat :—

	Sophia mill.		*Uitvlugt Factory.*
Average purity... ...	88.6	Average purity	85.8
„ tons sucrose per acre	0.979	Average tons sugar per acre	1.69

The figures for sucrose per acre, as determined at Sophia, were therefore all multiplied by the constant 1.73 (*i.e.*, $\frac{1.69}{0.979}$) to make them comparable to factory figures, and it is in this form that the results are presented.

THE RESULTS.

Fertilizer, lb per Acre	Fertilizing constituents per acre, lbs.			Sugar per acre,	Increment over Control, Sugar per acre,	Value of Increment per acre over Control with sugar at $44 per ton,	Cost of Manures and Application, per acre,	Profit per acre on Manuring,
	N	P_2O_5	K_2O	Tons	Tons	$	$	$
Sulphate of Ammonia (571·5 lbs.)	120			2·18	1·25	55·00	14·44	40·56
do. (381 lbs.)	80	...	...	2·06	1·13	49·72	9·66	40·06
do. (190·5 lbs.)	40	..	...	1·75	0·82	36·08	4·98	31·10
Sulphate of Ammonia (190·5 lbs.) and Superphosphate (277 lbs.)	40	51	...	1·75	0·82	36·08	8·68	27·40
H.O.P. No. 1 (811 lbs.)	40	70	...	1·68	0·75	33·00	18·96	14·04
H.O.P. No. 2A (930 lbs.)	40	51	97	1·49	0·56	24·64	24·37	·27
Control	..			0·93	...	..	...	...

In executing an experiment of this nature it is impossible to eliminate entirely variations due to soil differences, weeds, drainage, personal equation of the experimenter, etc. Unless therefore the difference between the mean yields of any two formulae is great enough to be almost entirely due to difference in treatment (*e.g.*, chances of 20 to 1), it is not usual to draw definite conclusions therefrom.

The yields of sugar per acre in this table are means of five plots of each treatment. Statistical analysis of the results indicates that any difference in the mean

yields greater than 0.43 ton sugar per acre has a 20 to 1 chance of being due to difference in manurial treatment. Any such difference, *i.e.*, more than 0.43 ton sugar per acre, is considered to be statistically significant.

The valuation placed on manures in the above table is based on the prices at the time of application.

CONCLUSIONS.

On the area in question and under the conditions of the experiment :—

1. There is no statistically significant difference between the yields of second ratoons obtained from :

40 lb. nitrogen per acre as sulphate of ammonia,

" " " " " " " " and 51 lb. phosphoric anhydride per acre as superphosphate of lime.

and 70 lb. phosphoric anhydride per acre as H.O.P. No. 1.

51 lb. phosphoric anhydride per acre and 97 lb. potash per acre as H.O.P. No. 2 A.

2. In view of the relative costs of the manures mentioned in 1, sulphate of ammonia alone is to be preferred to either of the fish manures or to a combination of sulphate of ammonia and superphosphate.

3. The increases in the yield obtained from the application of 80 and 120 lb. of nitrogen per acre as sulphate of ammonia over the 40 lb. dressing are not statistically significant, but the results suggest that if the experiment had been designed to compare the relative values of these three dressings of sulphate of ammonia, a dressing of 80 lb. nitrogen would probably have been most profitable.

II. SOPHIA (FIELD 17 EAST.)

The principal object of this experiment was to determine the value of the Kerazotine and Leathermeal, two nitrogenous organic manures, in comparison with sulphate of ammonia. The Kerazotine and Leathermeal were kindly supplied free of cost by the Comptoir d'Engrais et de Matières Premières, of 142, Avenue du Margrave, Antwerp, Belgium.

Kerazotine is guaranteed to contain 12 to 14 per cent. Nitrogen, of which 70 to 75 per cent. is soluble in water. Its price, at the time of application, was $75.87 per ton of 2240 lb., c.i.f.

Leathermeal is guaranteed to contain 8.5 to 10 per cent. Nitrogen, of which about 70 per cent. is soluble in water. Its price, at the time of application, was \$47.65 per ton of 2240 lb., c.i.f.

The sulphate of ammonia used contained 19.8 per cent. Nitrogen. It was bought locally at \$60.00 per ton of 2240lb.

THE EXPERIMENT.

Follett-Smith, in his Soil Survey of the Sophia Sugar Experiment Station,* reports on Field 17 East as follows:

	Topsoil.	*Subsoil.*
	Markedly acid fine silt.	Markedly acid fine silt
Moisture at point of stickiness	39.5 per cent.	42.3 per cent.
Sand	25.2 „ „	21.0 „ „
Index of texture	33.0 „ „	38.0 „ „
Normal pH	5.3 „ „	5.0 „ „
Exchange pH	4.2 „ „	4.4 „ „
Available potash	0.0097 per cent.	—
„ phosphate	0.0010 „ „	—
Organic matter	1.24 „ „	—

Field 17 East was planted to B.H. 10 (12) during the second week of October 1929. The manures were applied during the third week of November. Five formulæ were used in five replicates, the experiment taking the form of a Latin Square with 25 plots, the area of each plot reaped and weighed being 0.056 acre. All the banks (interrows) were forked in early December, 1929. The field was weeded five times during the growth of the canes. At each of the first four weedings the canes were moulded (*i.e.*, soil raked to the clumps), and at the last weeding the dried leaves removed from the canes.

As the canes appeared to be mature, some samples were taken on December 15, 1930. These revealed, for the experimental mill juice, a purity of 94.34 and an average of 18.68 per cent. sucrose in juice. However, owing to shortage of water occasioned by drought, it was not possible to transport cane, and reaping had to be deferred until February 23, 1931. At this stage the average purity of the juice from the experimental mill had dropped to 91.5, and the sucrose in juice to 16.43 per cent. As is usual in local practice, the canes were burnt to facilitate reaping.

* *Agr. Jour. of B.G.*, Vol. III. pp. 63–71.

The following table shows the rainfall at Sophia during the experimental period compared with the average precipitation.

		Rainfall 1929-1931, inches.		Average Rainfall 1921-1930, inches.
October, 1929	...	0.92	...	3.64
November	...	6.84	...	6 68
December	...	5.06	...	14.78
January, 1930	...	9.13	...	7.61
February	...	3.69	...	3.76
March	...	0.90	...	3.89
April	...	10.38	...	4.41
May	...	13.89	...	11.67
June	...	12.96	...	14.86
July	...	22.76	...	10.98
August	...	6.19	...	8.50
September	...	0.99	...	3.07
October	...	1.37	...	3.64
November	...	1.60	...	6.68
December	...	8.94	...	14.78
January, 1931	...	2.13	...	7.61
February	...	3.58	...	3.76
	Total	111.33		130.32

The canes from this experiment were sold to Plantation Ogle. Through the courtesy of the Estate Authorities it is possible to give below a comparison of the juice as expressed by the experimental mills and that expressed by the factory mills a day later:—

		Laboratory mill Normal juice.		*Factory mill* Normal juice.
Per cent. sucrose in juice	...	16.43	...	15.17
Purity ...	...	91.50	...	86.00

With the normal juice figures from the factory mill, and by using the average figures for (1) extraction of juice per cent. cane, and (2) recovery of sucrose in juice, as obtained at nine local factories (making together over 90,000 tons of sugar), it has been possible to calculate, from the actual weights of canes noted, the yield of 96° sugar per plot. It is in this form that the results are presented overleaf.

The Results.

Fertilizer per acre, lb.	Nitrogen applied per acre, lbs.	Sugar per acre, Tons.	Increment over Leathermeal. Sugar per acre, Tons.	Value of Increment over Leathermeal, per acre with sugar at $44.00 per ton, $	Cost of Manures and Application per acre, $	Profit per acre on Manuring over Leathermeal,
Sulphate of Ammonia 450·0	90	3.13	0.64	28.16	12 35	30.40
„ „ 375·0	75	2.97	0.48	21 12	10.34	25.37
„ „ 300·0	60	2.81	0 32	14.08	8.34	20.33
Kerazotine 462·0	60	2.53	0.04	1.76	15.95	0.40
Leathermeal 667·0	60	2.49	...	.	14 59	.

In executing an experiment of this nature it is impossible to eliminate entirely variations due to soil differences, weeds, drainage. personal equation of the experimenter, etc. Unless therefore the difference between the mean yields of any two formulae is great enough to be almost entirely due to difference in treatment (*e.g.*, chances of 20 to 1), it is not usual to draw definite conclusions therefrom.

The yields of sugar per acre in this table are means of five plots of each treatment. Statistical analysis of the results indicates that any difference in the mean yields greater than 0.466 ton sugar per acre has a 20 to 1 chance of being due to difference in manurial treatment. Any such difference, *i.e.*, more than 0.466 ton sugar per acre, is considered to be statistically significant.

The valuation placed on manures in the above table is based on prices at the time of application.

Conclusions.

On the area in question and under the conditions of the experiment:

1. The differences in yield obtained from 60 lbs. nitrogen per acre supplied either as sulphate of ammonia or kerazotine or leathermeal are not statistically significant. As the application in the form of sulphate of ammonia is about 45 per cent. cheaper, this is to be preferred, the more so as there appears to be a tendancy for the sulphate of ammonia to give higher yields than the kerazotine or leathermeal.

2. 75 lbs. nitrogen per acre as sulphate of ammonia gave a statistically significant increase over 60 lb. nitrogen as leathermeal.

3. 90 lb. nitrogen per acre as sulphate of ammonia gave a statistically significant increase over 60 lb. nitrogen as kerazotine or leathermeal.

4. There would appear to be indications of a steady and remunerative increase in yield as the dose of nitrogen (as sulphate of ammonia) is increased from 60 to 90 lb. per acre, but the differences are not sufficiently great to allow of a definite conclusion being drawn.

This experiment will be continued on the first ratoons and any residual effect there may be from the organic manures, which are perhaps slower in acting than sulphate of ammonia, will then be observed.

Summary.

The results of a manurial experiment on second ratoons of D. 625, executed on a markedly acid heavy silt at Pln. Uitvlugt, show that H.O.P. No. 1 and H.O.P. No. 2 A, fish manures sold by the Humber Fishing and Fish Manure Co., Ltd., of Hull, England, are no more efficient than sulphate of ammonia at an equivalent dose of Nitrogen, though costing 3 to 4.7 times as much. The further conclusion is tentatively drawn that 80 lb. Nitrogen per acre as sulphate of ammonia (approximately 400 lbs.,) would probably prove an economic dose for second ratoons on this land.

An experiment on plant canes of B.H. 10 (12), executed on a markedly acid fine silt at the the Sophia Sugar Experiment Station, has demonstrated that Kerazotine and Leathermeal, nitrogenous organic manures sold by the Comptoir d'Engrais et de Matières Premières, of 142 Avenue du Margrave, Antwerp, Belgium, are not more efficient than sulphate of ammonia at an equivalent dose of nitrogen, though costing nearly twice as much. The further conclusion is tentatively drawn that it would probably be economically sound to apply at least 90 lb. Nitrogen per acre as sulphate of ammonia (approximately 4 cwt.) to plant canes on this land.

Acknowledgements.

It is with great pleasure that the writer acknowledges his indebtedness to the Chemical Division of the Department of Agriculture for analyses of soils, manures and juices, to his colleagues of the Sugar Experiment Station for their co-operation in the execution of the experiments, and to Mr. J. D. Gillespie, Agricultural Superintendent, West Demerara, for assistance in connection with the Uitvlugt experiment. Special mention must be made of the helpful co-operation of the Manager and Staff of Plantation Uitvlugt.

A BOTANICAL SURVEY OF THE RUPUNUNI DEVELOPMENT COMPANY'S RANCH AT WARANAMA, BERBICE RIVER

BY

E. B. MARTYN, B.A. (Oxon.).

Botanist & Mycologist, Department of Agriculture.

A survey of the Rupununi Development Company's Ranch at Waranama was carried out in the early part of September 1929, in conjunction with the Government Veterinary Surgeon and the Chemist-Ecologist, its object being the investigation of the pasturage available for cattle.

The ranch is situated west of the Berbice River on the Wiruni-Ituni savannahs. It is approximately 80-90 feet above sea level, and is some 60 miles inland. The country consists of open undulating grass land, with scattered areas of forest, varying in extent from several square miles, to narrow belts of trees bordering creeks and streams. The appearance of this region agrees well with the general descriptions given by Schomburgk (1) of the savannahs of British Guiana. A belt of similar savannahs, broken at intervals, spreads across northern South America, north of the Amazon, from the foothills of the Andes, nearly to the Atlantic. The detailed nature of the vegetation changes with the degree of elevation above sea level, rainfall, etc., but the general appearance would seem to be more or less uniform.

The area surveyed in this case was some 70 square miles in extent. Special attention was paid to the pasture grasses, but a collection was also made of other species flowering on the open savannah at the time of the visit, which was early September. The floral display at this season was not so complete as would have been found in April at the beginning of the rains, and it is possible that a number of common plants not in flower were overlooked.

The open savannah is covered principally by grasses and sedges growing in tufts, with bare patches of sandy soil between. At a rough estimate only some 60 per cent. of the soil appears to be occupied by vegetation, but the luxuriance of the latter varies to some extent with the season of the year, the intensity of the grazing, and the time which has elapsed since any area was last burnt. The country in question, being a cattle ranch, is subjected to periodic burning to

(1) SCHOMBURGK, R. *Reisen in Britisch Guiana in den Jahren,* 1840-1844. Vol. III, p 797. (Leipzig 1848).

provide young grass for the animals, but the savannah regions, in general, take fire from time to time during the dry weather. These fires, however, do not usually burn for more than 24 hours, as they are quenched by the dew.

Schomburgk aptly likens the appearance of the forest or bush areas to oases rising out of the savannahs as islands from the sea. A marked characteristic is the abrupt transition which takes place between 'bush' and open savannah, the intermediate zone being seldom more than two or three yards in width. Seen at a distance this sharp delimitation is so striking that it gives to the forest areas the appearance of their being fenced off from the surrounding open country. The trees and shrubs are principally of a rather small-leaved type, members of the *Myrtaceae* and *Malpighiaceae* being commonly found. The nature of the vegetation in these areas, however, depends largely on the amount of water present. In swampy depressions, too wet for forest, the Aeta palm, *Mauritia flexuosa*, occurs; sometimes as a few scattered trees, elsewhere forming large belts of 'palm forest,' similar to those found in the Swamp Savannahs near the coast. The steeper banks of creeks and streams in the open savannah are also bordered by a fringe of arboreal vegetation, amongst which the Kokerite palm, *Maximiliana regia*, is usually conspicuous.

The principal object of the survey was the examination of the flora of the open savannah with regard to its possibilities as pasturage for cattle. In the areas examined, four species of grass and two sedges were found to be the chief constituents of the vegetation, the relative proportions of each varying slightly in different localities, a variation which could to some extent be correlated with a change in the soil. The two main soils have been described by the Chemist-Ecologist [2] as a brown sand type and a sand hill type. On the latter the principal grasses in flower were *Trachypogon plumosus*, *Axonopus aureus*, *Andropogon leucostachyus* and *Aristida setifolia*, this order indicating the relative degree of frequency with which each occurs. To the list may be added *Leptocoryphium lanatum*, though less prevalent than any of the remainder. The three first named grasses, together with the sedge *Rhynchospora pterocarpa*, constitute the greater part of the vegetation. Small tufts of *Stenophyllus coniferus* are however also widespread in the bare patches of soil, between the large clumps of the grasses and other sedges. *T. plumosus* is distinctly dominant, and usually accounts for about one-quarter of the Grass-Sedge association. On the brown soil type, the vegetation as a whole is somewhat thinner, and sedges become more prevalent, while *Andropogon leucostachyus* and *Aristida setifolia* are less frequent.

The constituents of this Grass-Sedge association are all of a dry and xerophytic nature. In dry weather the clumps of grass consist, for the greater part, of dead and dry material, with a few green leaves on the top. As the cattle cannot

(2) FOLLETT-SMITH, R.R. Report of an Investigation of the Soils and of the Mineral Content of Pasture Grasses occurring at Waranama Ranch, Berbice River. *Agr. Jour. of B.G.* III, 3, p. 142, 1930.

graze on the grass in this condition, burning is necessary from time to time, the young freshly springing vegetation being more palatable. The only grasses of this Association cropped by cattle are *T. plumosus*, and to a lesser extent, *Axonopus aureus*. In addition to these, however, the animals crop the various herbs and bushes which grow on the savannah, and more especially those on the ant hills, and in the narrow transition zone between open country and bush.

Scattered over the savannah at intervals are slightly hollowed areas, sometimes a hundred yards or more across, waterlogged in the wet season, but dry during periods of drought. Such areas, which may be designated as 'pans,' possess the best pasturage, and cattle tend to collect in their neighbourhood. The smaller depressions are sometimes only marked by a change in the nature of the grasses, and the appearance of some other species which are more palatable to cattle. *T. plumosus* becomes less prominent and *A. leucostachyus* rather more frequent, and in addition, *Eleusine indica* (an introduced grass) appears, together with clumps of *Andropogon bicornis*. In the more clearly defined 'pans' this latter grass, sometimes accompanied by *Axonopus attenuatus*, is of common occurrence, and both are cropped by the cattle. The lowest part of the 'pans', where the ground is devoid of grass, and water stands during wet weather, is often occupied by an almost pure stand of *Psidium Araca*, a low shrub.

Throughout the Grass-Sedge association, solitary herbaceous plants are scattered, often with prominent bright flowers. *Pavonia speciosa*, *Palicourea rigida* and *Byrsonima verbascifolia*, three of the commonest in flower at the time, have a characteristic stunted habit, their shoots never being seen above one foot in height and possessing in common a root stock well protected by a thick outer covering of cork. Several other small flowering plants are universally distributed, including a number of Legumes. The bright flowers of *Amasonia erecta*, and the purple clusters of *Tibouchina aspera*, are conspicuous everywhere.

The level of vegetation is broken at intervals by stunted bushes, chief of these being *Byrsonima coccolobaefolia* and *Curatella americana*, which in certain areas become a dominant feature. Groups of two or three palms, *Astrocaryum sp.* or *Maximiliana regia*, are also to be seen occasionally. The most noticeable irregularities, however, in the landscape of the open savannah, are the patches of thicker vegetation, arising on the low mounds which are nests of the Coushi ant (*Atta sp.*). These ant hills are more prevalent in some areas than in others. They are usually rather higher at one end, and the vegetation upon them differs from that found on the ordinary savannah. The degree of difference, however, varies from those hills which bear only a slightly richer herbaceous vegetation, to others on which bushes and small trees occur. In these differences a definite plant succession can be traced, exactly similar to that found in the narrow transition belt between the forest areas and the open savannah.

Three types of hill may be recognised. On the first, the vegetation resembles that around it, but two new sedges occur, *Rynchospora Cephalotes* and *Dichromena ciliata*. The trailing *Sipanea pratensis* becomes established, and *Tibouchina aspera* grows more readily than elsewhere. In the next stage, *R. Cephalotes* attains greater prominence, and several species of *Miconia*, including *M. macrothyrsa*, are found, and also seedlings of *Byrsonima spicata*. *Siparuna guianensis* becomes apparent, together with *Eugenia Benthamii*, and several other bushes which were unidentifiable at the time. These woody plants are situated on the higher portions of the mounds. On the lower part are to be seen *Panicum Rudgei* and clumps of *Bulbostylis junciformis*. Legumes such as *Cassia riparia* and *C. hispidula* also present themselves here.

In the third and final stage a little island of bushes is formed, surmounted by one or two small trees. *Byrsonima spicata* is the dominant tree, accompanied by shrubs such as *Miconia rubiginosa*, *Solanum asperum*, *Wulffia baccata*, etc. In addition *Stylosanthes guianensis var. gracilis*, *Baccharis rufescens*, *Borreria. ocymoides* and *Bulbostylis asperula* are usually present, together with 'Razor grass,' *Scleria bracteata*, climbing over the bushes.

This definite gradation, finding an exact counterpart in the transition zone between forest and Savannah, is somewhat difficult to interpret. Without carrying out observations over a number of years, it is impossible to decide whether the boundaries between forest and Savannah can be considered permanent. The two types of vegetation may be existing side by side in a state of equilibrium, or one may gradually be encroaching upon the other.

It is probable that fire plays some part in any changes taking place, but no instances were observed where it had made more than slight inroads into the forest, and that this did not usually occur was the opinion of the Ranch Manager. On the other hand, no area was seen in which the forest appeared to be penetrating into the Savannah, except in the case of the ant hills. These, by reason of their slight elevation, may possibly be able to escape the full intensity of a fire, and support a more permanent type of vegetation. But the forest edge is not always bordered by nests, though these are usually near to the forest when they do occur, the ants being more plentiful in such a situation. The true significance of this ant hill succession, in the absence of further observations, remains for the time being a matter of speculation.

Close to the forest, though not in the actual transition zone, a number of plants are often found which are not seen elsewhere. These include several legumes, such as the trailing and deeply rooted *Desmodium adscendens*, readily eaten by cattle, and solitary plants of *D. barbatum*, together with *Eriosema fusiforme* and *E. crinitum*. The grass *Leptocoryphium lanatum* is found more commonly near the bush than in the open, and in areas where fire has made slight inroads into the forest, *Panicum ? millegrana*, which is also cropped by cattle, becomes established.

Mention must finally be made of the areas of scrub known as "Muris," which occur at intervals in the region surveyed. These vary somewhat in size and form. The soil is a white quartz sand quite different to that of the surrounding country and a definite and distinct plant association, markedly xerophytic in character, is found. Sometimes the "Muris" are on the summit of a rise, in which case a belt of bare sand usually divides their vegetation from that of the normal savannah. In other cases, a more gradual transition takes place.

The Muri vegetation consists of thick patches of bushes and small trees, interspersed with open areas, on which the vegetation is of a very sparse nature. *Clusia nemorosa* is usually the largest component of the scrub, and arises in the centre of the thickets, attaining a height of fifteen to twenty feet. It is sometimes accompanied by stunted trees of *Byrsonima spicata*. A shrub, *Pagamea capitata*, normally some six feet high, and the low growing "Muri bush", *Humirium floribundum var. guianensis*, make up the remainder of the thickets.

The open areas of the Muri are sparsely occupied by *Cassia uniflora* and clumps of "Muri Grass", *Axonopus attenuatus*, together with *Cryptangium uliginosum* and scattered shoots of *Trachypogon plumosus* Small patches of the fern *Schizea incurvata* are always present, and two species of *Borreria* (*B tenella and B. suaveolens*) are common to the association. *Syngonanthus spp.* and lichens such as *Cladonia rangiferina* are to be found here and there on the sand.

To return to the consideration of the Savannah as a whole, it may be said that the vegetation, in the area surveyed, is of poor feeding value for cattle. There is no profusion of any bush or shrub which appears to afford much nourishment, and the more prevalent grasses cropped are not only dry and fibrous in appearance, but have been shown on analysis (2) to be markedly deficient in mineral constituents.

Attempts at introducing pasture grasses from the coast do not seem to have met with any great success. "Bahama Grass", *Capriola dactylon*, was seen in one paddock near the ranch buildings. It had, however, been established with the help of weeding, and it is probable that without such assistance it would become subdominant to other grasses. "Para Grass", *Panicum barbinode*, had also been grown on a small scale, but, at the time of inspection, was for the most part dry and brown, with only one or two green leaves on each shoot.

As has been pointed out in the Reports of the Chemist-Ecologist (2) and the Government Veterinary Surgeon, (3) cattle pastured in this area suffer from a mineral deficiency.

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(2) *loc cit*

(3) BONE, MAJOR T. Investigation of Ranching Problems of the Waranama Savannah, Berbice River, *Agr. Jour of B G.* III, 3, p. 160, 1930.

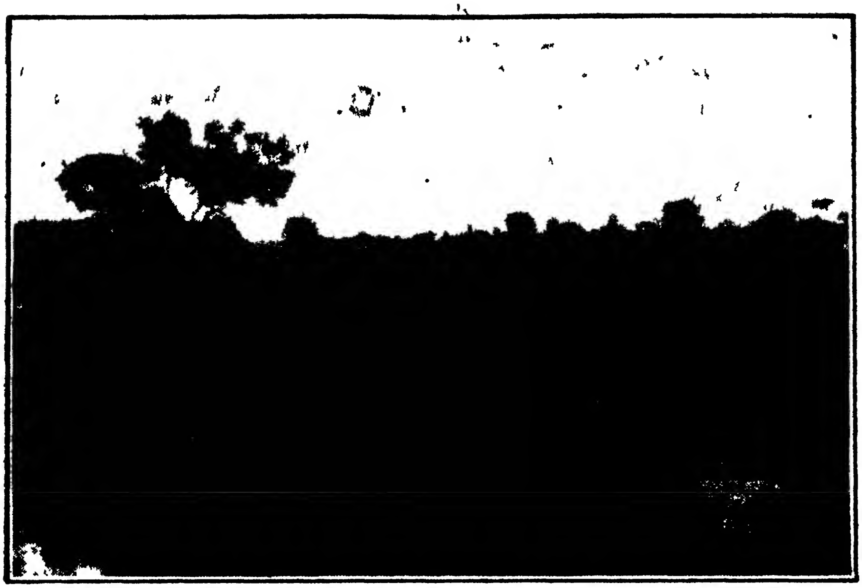


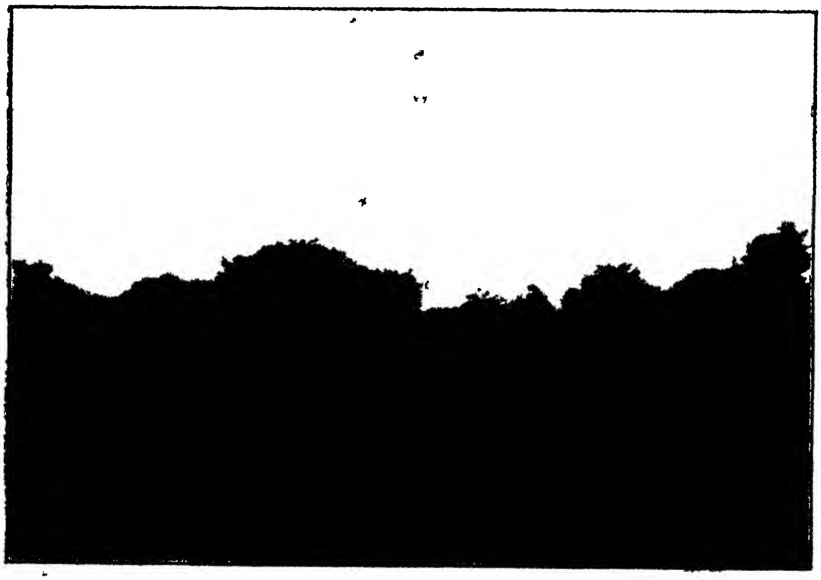
Photo by *C. L. Wardlaw.*

A Pan, showing dumps of *Andropogon* [illegible] in the foreground, with *Psidium* sp. behind.

Photo by *C. L. Wardlaw.*

The margin of an area of "bush" showing the abrupt termination between grassland and forest.

Muri, showing bare patches of white sand in the foreground backed by scrub of *Clusia nemorosa*, *Pagamea capitata* and *Humirium floribundum*.



Typical Savannah, showing an ant hill in the ‘~~second~~ stage’ in the foreground with others in the ‘third stage’ behind.

Suggested remedies are the introduction of bone meal feeding, and the retention of the cattle in certain selected areas, where it might be possible to establish a regular system of close cropping, or introduce forage plants of higher feeding value than the indigenous flora. A number of plants are known from various parts of the world, which have proved well adapted to xerophytic conditions, while they are, at the same time, of good nutritive value to cattle. Their introduction into areas such as that surveyed would be largely a matter of trial. It is a question whether the introduced plants could assimilate a sufficient quantity of mineral matter from a soil markedly deficient in plant nutrients, to give them the feeding value that they possess in other localities.

In conclusion I wish to express my thanks to Mr. N. Y. Sandwyth of the Royal Botanic Gardens, Kew, and Dr. H. A. Gleason of the New York Botanical Gardens, for the identification by each of a number of the plants collected in the area concerned.

SUMMARY.

(1) The Rupununi Development Company's Ranch lies on the Wiruni-Ituni savannahs. The savannahs consisting of open country interspersed with areas of bush, possess a vegetation similar in the main to that found over large areas of a like nature in northern South America. A general description is given.

(2) The vegetation of the open savannahs, in the area surveyed, is made up of a Grass-Sedge association, the main constituents of which are enumerated. The general level is broken at intervals by stunted bushes and trees, and in places, by ant hills on which a somewhat richer vegetation is found.

(3) The best pasturage for cattle is found in the depressed areas designated as 'pans,' where certain additional grasses occur.

(4) The vegetation of the ant hills is described in some detail. A definite succession can be traced, exactly similar to that found in the narrow transition belt between the open savannah and the forest areas.

(5) The distinct plant association, found in the 'Muris,' or white sand areas, is described.

(6) The question of the suitability of this area for cattle is discussed.

APPENDIX.

(a) Plants collected on the Wiruni-Ituni savannahs by E. B. Martyn in September, 1929.

Gramineae.

Andropogon bicornis L.
A. leuchostachyus H B K.
Aristida setifolia H.B.K.
Axonopus attenuatus (Presl.) Hitchc.
A. aureus Beauv.
A. compressus (Swartz) Beauv.
Eleusine indica (L.) Gærtn
Eragrostis maypurensis (H B.K.) Steud.

Gramineae—*contd.*

Leptocoryphium lanatum (H.B.K.) Nees.
Panicum ? millegrana Poir.
Panicum rudegi Roem. and Schult.
Trachypogon plumosus (Humb. and Bonpl.) Nees.

Cyperaceae.

Bulbostylis asperula C. B. Clarke.
B. junciformis Kth. var. *conostachya* Lindm.
Cryptangium leptocladium Boeck.
Cyperus sphacelatus Rottb.
Dichromena ciliata Vahl.
Rynchospora cephalotes Vahl.
R. pterocarpa R. and S.
Scleria bracteata Cav.
Stenophyllus coniferus (Kth.) Britton.

Leguminosae.

Cassia cultrifolia H.B.K.
C. hispidula Vahl.
C. riparia H.B.R. sens. Bth.
C. uniflora var. parvifolia Bth.
Desmodium adscendens D.C.
D. barbatum Bth. and Oerst.
Eriosema crinitum (H.B.K.) Mey.
E. fusiforme Rusby.
Indigofera pascuorum Bth.
Phaseolus gracilis Poepp. e. Bth.
Stylosanthes guianensis Sw. var. *gracilis* Vog.

Rubiaceae.

Borreria ocymoides (Burm.) D.C.
B suaveolens Mey.sens. Miq.
B. tenella C. & S. sens. K. Schum.
Pagamea capitata Benth.
Palicourea rigida H.B.K.
Sipanea pratensis Aubl.

Melastomaceae.

Clidemia rubra (Aubl.) Mart.
Miconia macrothyrsa Benth.
M. rubiginosa (Bonpl.) D.C.
Tibouchina aspera Aubl.

Compositae.

Baccharis rufescens Spreng.
Centrantherum muticum Less.
Eupatorium amygdalum Vahl.
Wulffia baccata (L. fil.) Kye.

Malphigiaceae.

Byrsonima coccolobaefolia (H.B.K.)
B. spicata Rich.
B. verbascifolia Rich.

Dilleniaceae.

Curatella americana L.
Tetracera asperula Miq.

Gentianaceae.

Coutoubea spicata Aubl.

Guttiferae.

Clusia nemorosa G.F.W., Mey.

Humiriaceae.

Humirium floribundum var. guianense (Bth.) Urb.

Malvaceae.

Pavonia speciosa H.B.K.

Monimiaceae.

Siparuna guianensis Aubl.

Myrtaceae.

Eugenia Benthamii Berg.
Psidium Araca Raddi.

Orchidaceae.

Sarcoglotis aphylla Schltr.

Polygalaceae.

Polygala longicaulis H.B.K.

Solanaceae.

Solanum asperum L.C. Rich.

Verbenaceae.

Amasonia erecta L.

Filices.

Schizea incurvata Schlr.

Lichenes.

Cladonia rangiferina Hoffm.

(b) Plants collected on Wiruni-Ituni Savannahs by A. A. Abraham, February–May, 1919, and not included in the above list. Identified at New York Botanic Gardens.

Graminae.

Elyonurus adustus (Trin.) Ekman.

Cyperaceae.

Sporobolus aeneus (Trin.) Kunth.
Rynchospora Subplumosa Clarke.

Cyperaceae—*contd.*

Stenophyllus romostachys (Boeck.) Britt.
S. Tenuiflorus (Rudge) Britt.

Leguminosae.

Aeschynomene paniculata Willd.

Leguminosae—*contd.*

Cassia viscosa H.B.K.
Clitoria guianensis (Aubl.) Benth.
Cracca brevipes Benth.
Crotalaria maypurensis H.B.K.
Galactia Jussiaena H.B.K.
Stylosanthes viscosa Sw.
Zornia diphylla (L.) Per.

Rubiaceae.

Diodia rigida Ch. & Schl.
Retinophyllum Schomburgkii Muell. Arg.

Compositae.

Ichthyothera terminalis (Spreng.) Blake.
Orthopappus angustifolius (Sw.) Gl.

Asclepiadaceae.

Oxypetalum capitatum Decne.

Aquifoliaceae.

Ilex daphnogenea Reiss.

Convolvulaceae.

Evolvulus sericeus Sw.
Ipomoea albiflora Moric.
Ipomoea juncea Choisy.

Iridaceae.

Sisyrinchium alatum Hook.

Ochnaceae.

Sauvagesia erecta L.
S. Sprengelii St. Hil.

Rosaceae.

Hirtella racemosa Lam.

Scrophulariaceae.

Buchnera rosea H.B.K.

Turneraceae.

Turnera odorata Hook.

Ulmaceae.

Trema micranthum (L.) Blume.

(c) Additional plants, not included in either of the above, from a list compiled in 1884 by G. S. Jenman, of plants seen on the Corentyne Savannahs, and considered by him as typical of the general Savannah flora of the colony.

Leguminosae.

Cassia pilifera.
Centrosema brasiliense.
Crotalaria stipularia.
Desmodium venosum.
Phaseolus pilosus.

Caryophyllaceae.

Polycarpae brasiliensis.

Compositae.

Pectis elongata.
Wedelia grandiflora.

Cucurbitaceae.

Cayaponia angustiloba.

Euphorbiaceae.

Croton lobatus.
Jatropha urens.

Malphigiaceae.

Byrsonima crassifolia.

Malvaceae.

Pavonia cancellata.
Sida rhombifolia.

Melastomaceae.

Pterolepis pumila.

Pedalineae.

Craniolaria annua.

Sterculiaceae.

Melochia hirsuta.

Turneraceae.

Turnera hirta.
T. ulmifolia.

Violaceae.

Ionidium Ipecacuanha.

THE RICE CATERPILLAR*

BY

L. D. CLEARE, Jr., F.L.S., F.E.S.

Entomologist, Department of Agriculture, British Guiana.

Of the insects which attack the rice plant in British Guiana one of the more important is the Rice Caterpillar. Almost every year towards the commencement of the wet seasons, between February and April and again in November, outbreaks of this insect, of a greater or lesser extent, occur. Periodically, and usually after a period of excessive dry weather, these outbreaks assume extensive proportions and at such times serious damage is inflicted on this crop. The loss occasioned to the industry through the rice caterpillar is, therefore, sufficient to warrant the attention of all rice growers.

THE STAGES OF THE INSECT.

The Rice Caterpillar like all other caterpillars is an immature stage, and in this instance the adult insect is a moth. In all there are four distinct stages of development through which it passes—the egg (fig. 1), the caterpillar or larva (fig. 2), the chrysalid or pupa (fig. 3), and finally the adult moth (fig. 4). There are few persons in the Colony, however, who are familiar with it except as a caterpillar or larva feeding upon young rice plants.

THE EGG.

The eggs (fig. 1) are invariably deposited in masses, the number of eggs in a mass varying from 9 to as many as 300 or more, and in some instances are laid one upon another in a double layer. The eggs are often covered with a fine down of a light greyish colour which gives the masses a characteristic appearance. The individual eggs are small, being about a third the size of the head of an ordinary pin (0.4 mm.), and when first laid are a greenish grey in colour, becoming darker later, until, when they are ready to hatch they appear blackish.

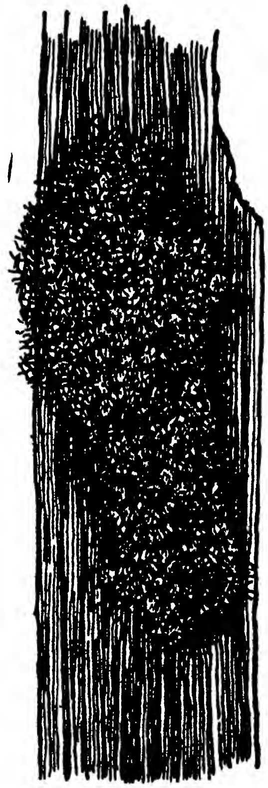


Fig. 1.—Egg of the Rice Caterpillar. About three times natural size. (Redrawn after Walton and Lugnibill.)

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*Laphygma frugiperda S. & A.

Department of Agriculture, Entomological Circular No, 3,

THE CATERPILLAR OR LARVA.

The growth of the larva from its hatching from the egg until it becomes full grown is very rapid and occupies, when attacking rice, about 16 days, though there is some variation in this period. The larval stage is the only destructive stage of the insect.

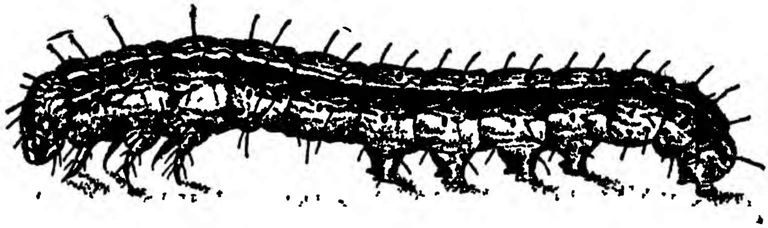


Fig 2—Full grown larva of the Rice Caterpillar About three times natural size (Redrawn after Walton and Lugnibill)

When full grown the caterpillar (fig. 2) measures about 1¼ ins. (30-34 mm.) in length, and on the upper surface is black in colour with three white or pale cream stripes extending its entire length, the central one being less distinct, with a similar but broader stripe on each side; the under surface of the body and the legs are greenish in colour.

THE CHRYSALID OR PUPA.

When fully grown the larva leaves its food plant and seeks a place to transform to the pupa. Pupation normally occurs in the soil, and when the larva has been feeding on rice it usually makes its way to a nearby "mere," or bund, and crawls into a crack or under a clod of earth, or if the soil is loose enough, bores down into it and there forms an oval cell in which it pupates.

Fig 3—The Chrysalid or Pupa of the Rice Caterpillar About four times natural size (Re drawn after Walton and Lugnibill)

The pupa (fig. 3) is a dark reddish brown in colour, changing to black immediately before the emergence of the moth. The pupa measures over half-an-inch in length (14-17 mm.) by about one-sixth of an inch broad (4.5 mm.), it is somewhat stout for its length, with the abdomen tapering to a decided point. The pupal period lasts for 9 to 10 days after which period the adult insect or moth emerges.

THE MOTH OR ADULT.

The moth (fig. 4) is a dull coloured and rather inconspicuous insect, especially when at rest, and by the majority of persons will be seldom seen, or at least will not attract their attention. About half-inch in length, and with wings outstretched

has an expanse of about 1¼ inches, it is a dull reddish-brown on the fore wings, with varying markings according to the sex, the male bearing more white markings than the female, the hind wings of a creamy-white colour.

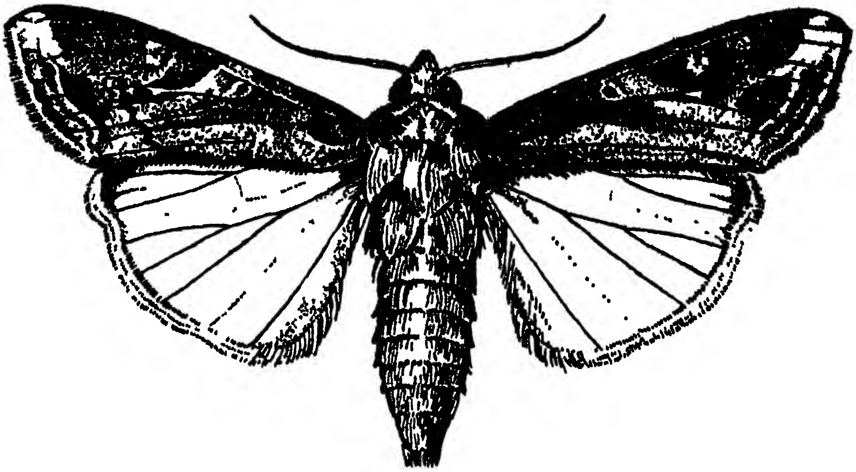


Fig 4—The Moth of the Rice Caterpillar About three times natural size. (Redrawn after Walton and Lugnibill)

The moths remain concealed during the daytime amongst vegetation or in other places offering suitable shelter, moving only when disturbed. When at rest the dark grey colour of the upper wings renders them inconspicuous, especially when resting on or near the ground. In the evening hours they become active, and mating occurs and eggs are deposited at this time.

DAMAGE INFLICTED.

The damage inflicted by the Rice Caterpillar takes place when the plants are quite young and only a few inches in height and, therefore, when they are still quite delicate. At this stage the plants are still in the nursery beds. When the caterpillars are young and first begin to feed on the rice plants they eat the green tissues of the leaves producing patches which later whither, but as they develop and increase in size they consume either the whole leaf or bite through it near its base thus causing it to fall. On account of the proximity of plants in the nursery the caterpillars can move freely from one plant to another, and, occurring as they do in almost countless numbers, in a short time will destroy the entire nursery, if control measures are not taken, and necessitate its re-sowing.

CONTROL MEASURES.

A careful watch should be kept for the appearance of the caterpillars amongst the young rice plants. and as soon as they are discovered steps should be taken to destroy them.

The simplest way of dealing with this pest is to submerge the attacked plants by the flooding of the nursery beds. In order to do this the "meres" or bunds, around the nursery beds, should be made of sufficient height to allow the plants to be completely covered with water.

As soon as the insects are observed attacking the plants the nursery beds should be flooded to such a height that the plants are covered by the water. The caterpillars will thus be dislodged from the plants and float on the surface of the water, and may then easily be collected and destroyed. The dislodgement of the caterpillars may be greatly aided, and their subsequent collection facilitated, by sweeping over the surface of the water and tops of the plants with a light long-handled broom made of twigs. If carefully done this will cause no injury to the plants. In this connection it is necessary to have the nursery beds small enough to allow any part of them being reached easily, and when the beds are being made this should be kept in view.

When a large number of nursery beds occur together, the different growers should co-operate in the destruction of the caterpillars. It is a duty which each grower owes to his neighbour. In this manner the best results are obtained and the caterpillars brought completely under control. Without such joint action amongst the growers the caterpillars may spread from one nursery to another.

Finally, the ground about the rice beds should be kept as free as possible from grass and other weeds. The rice caterpillar feeds on weed grasses in addition to rice, and it will be found that this practice will greatly help in reducing the incident of attacks, in addition to minimizing the damage when an attack occurs.

A SIMPLE TEST FOR SOIL REACTION.

BY

R. R. FOLLETT-SMITH, B.Sc., A.R.C.S.

Chemist-Ecologist, Department of Agriculture, British Guiana.

Soil samples may be examined for acidity or alkalinity by two distinct methods ;—

(1) by electrometric means, and

(2) by the use of indicators.

The first method calls for the possession of expensive apparatus and requires considerable technical skill in its manipulation. Of the colorimetric methods perhaps the simplest and least expensive is Comber's method.

COMBER'S METHOD FOR TESTING SOIL REACTION.

Comber's reagent is a five per cent. (5%) solution of potassium thiocyanate (or ammonium thiocyanate) in alcohol of 90 per cent. strength. The soil to be tested should be representative of the area from which it is obtained. Soil should be pared off the sides of five or six holes suitably spaced within the field. For cane soils, two samples are usually taken, the one down to the one-foot level (topsoil), and the other between the first and second foot levels (subsoil). The corresponding portions of soil from the different holes are broken up, mixed together, and air-dried. A portion of the dry soil is then powdered by rolling with a bottle or by gentle use of a hammer. A little of this powdered soil, say a level teaspoonful, is put into some small glass vessel such as a test tube or a liqueur glass, and about a tablespoonful of Comber's reagent poured on to it. The soil and liquid are shaken together and allowed to stand for twenty-four hours. At the end of this time, the colour of the settled liquid is noted. It will be either colourless or some shade of blood red.

The following table (Table I) shows the approximate correspondence between the colours obtained and the pH values, both for 'normal' (water suspension) and for 'exchange' (potassium chloride solution suspension) reactions.

This article is largely an abstract of a paper by F. HARDY and R. R. FOLLET-SMITH, appearing in the *Minutes and Proceedings of the Froghopper Investigation Committee*, Volume I, p, 245.

TABLE I.

COLOUR	INTENSITY OF ACIDITY	"NORMAL" REACTION	"EXCHANGE" REACTION
Colourless	Alkaline, neutral or very slightly acid	Above pH 6.4	Above pH 5.6
Pale pink	Very slightly acidic	pH 6.4	pH 5.6
Pink	Slightly acidic	pH 6.2	pH 5.3
Light red	Acidic	pH 5.9	pH 4.9
Red	Markedly acidic	pH 5.6	pH 4.6
Deep red	Highly acidic	pH 5.3	pH 4.3
Very deep red	Very highly acidic	pH 5.0 and below	pH 4.0 and below

It will be seen that very slightly acidic, neutral and alkaline soils all give *no colouration* with Comber's reagent. In order to differentiate between them it is necessary to use a standard solution of an iron salt, such as ferric chloride or iron alum. This is added to the colourless mixture of soil and Comber's reagent, a drop at a time, with a twenty-four hour interval between each addition, until a lasting pink colour is obtained.

Table II shows the approximate correspondence between the required number of drops of standard iron alum solution (96.5 grams per litre) and reaction values above pH 6.4

TABLE II.

NUMBER OF DROPS OF STANDARD IRON SALT SOLUTION	INTENSITY OF ACIDITY OR OF ALKALINITY	"NORMAL" REACTION	"EXCHANGE" REACTION
1 drop	Very slightly acidic	pH 6.6	pH 6.0
2 drops	Neutral	pH 7.0	pH 6.6
3 drops	Alkaline	pH 7.4	pH 7.0
4 drops	Markedly alkaline	pH 7.8	pH 7.5
More than 4	Highly alkaline	pH 8.0 and above	pH 7.5 and above

The figures in those tables, obtained by the examination of some 1,400 Trinidad soil samples, agree with those obtained in examination of a much smaller number of soil samples collected from the sugar cane lands of British Guiana.

It is hoped that this inexpensive and simple method of determining soil reaction may be of use upon the estates of the colony. Samples of soil, for the purposes of standardising the colours described in Table I, may be obtained from the Chemistry Division of the Department of Agriculture.

AN EXPERIMENT WITH BAMBOO UNDERDRAINAGE FOR SUGAR CANE.

BY

C. HOLMAN B. WILLIAMS, D.I.C.T.A.,

Sugar Cane Agronomist, Department of Agriculture, British Guiana.

INTRODUCTION.

Soil, topographical and rainfall conditions on the coastal flats of British Guiana force the sugar planter to lay out his fields in beds which are separated from each other by open drains. The fields themselves are usually bounded on three sides by trenches in which flat-bottomed scows, or punts, are navigated for transporting cane, and on the fourth side by a somewhat smaller trench, usually 14 to 16 feet wide and about 6 feet deep, into which empty, directly or indirectly, the open drains which separate the beds within the field. The beds themselves are usually 36 to 37 feet wide, their length depending on the size and lay-out of the field. The drains between the beds are 2 to 4 feet deep, 1 foot wide at the bottom, and 2 to 4 feet wide at top. Over a considerable portion of the sugar area, however, the stiff and clayey nature of the soil apparently causes the lateral movement of soil water to be very slow and the drains under discussion are then chiefly useful for taking off surface water and for draining narrow strips at the sides of the beds which run parallel to them, for the middle portions of the beds often remain waterlogged for some time after heavy rains, although the drains, 18 feet away, may be almost empty.

On the other hand the digging and maintenance of drains add greatly to the cost of sugar production, and their presence is a hindrance to mechanical cultivation. The situation would be greatly improved if :—

(a) A satisfactory instrument could be found for digging the drains, or

(b) Some or all of the drains could be replaced by some system of covered drainage, or

(c) The present drainage system could be made to function more efficiently.

Up to the present no satisfactory instrument has been devised for digging drains under local conditions.

It is said that tile drainage has been tried more than once in the past and has never proved successful. Mole draining is now being tried on some estates in addition to the open drains. Mechanical difficulties have been overcome and a satisfactory drain can be made at intervals across the beds opening into the usual open drains. Such mole drains will probably facilitate the drainage of the central portion of the beds and will also enable water taken into the open drains in dry weather to find its way under the beds and so up to the cane roots by capillarity, a more satisfactory and cheaper system of irrigation than the general flooding of the field now practised.

Whittles suggested, in place of the usual open drain, a covered drain, in which a plaited bamboo mesh is used to support the soil cover. In 1925 he gave his suggestion a trial in Field 12 West of the Sophia Sugar Experiment Station. The original open drains were suppressed and new drains, eighteen inches deep and eighteen inches wide, were dug 12 feet apart, lengthwise along the original beds and parallel to the position of the former drains.

In the centre of the bottom of these new drains a further excavation, six inches wide and eighteen inches deep, was made. On the shoulders thus formed a matting of plaited bamboo laths was placed, and the excavated soil was put on top and packed down. Due to depletion of staff the experiment appears to have received little attention in 1927 and 1928.

In 1928 the field appeared to be waterlogged and the underground drains, when examined, were found to be blocked at several points where the bamboo matting had decayed. The original open drains were redug to relieve the situation. The waterlogging still continuing, however, in 1929 Mr. C. Cameron, the Field Manager, opened ditches (drills), two feet deep and one wide, across the beds from open drain to open drain, one being made on every other bank (inter-row, canes being usually planted in British Guiana across the beds in continuous rows, 5 to 6 feet apart at right angles to the open drains). At the bottom of these bed drills he placed 8 bamboos 18 feet long, four on the one half of the bed being placed end to end with four on the other half. The bamboos were covered with several inches of cane trash and the disturbed soil replaced on top. This modification appeared to work very satisfactorily, and it was possible just after the heavy rains of June 1929 to see the water pouring from the ends of the bamboos which projected slightly into the open drains.

THE EXPERIMENT.

The results obtained from Cameron's modification led to the laying out of a preliminary trial in Field 4 West, Sophia, to determine the effect of the extra bamboo drains on the yield of cane. Follet-Smith classifies the topsoil of Field 4 as a markedly acid heavy silt (Index of texture 41, exchange reaction pH 4.1, lime requirement 6 tons per acre) and the subsoil as a markedly acid clay (Index of texture 48, exchange reaction pH 4.3, lime requirement 4.3 tons per acre). The soil is very deficient in organic matter. It has been in continuous cultivation to cane for 10 years and has never been mechanically tilled during that period, nor has it ever been flood-fallowed.

It was decided to compare the usual system (open drains dissecting beds 36 feet wide) with:

(a) A similar system to which one of Cameron's bamboo drains was added across the bed at every other inter-row between the canes, i.e., 10 feet apart;

PLATE III.

Covered bamboo drain being laid across sugar cane bed. (Note layer of dried cane leaves between bamboos and covering soil).

(b) A system similar to (a) in all respects save that the septa at the nodes of the bamboos were pierced with an iron rod before the bamboos were put in place (to facilitate the piercing the bamboos were cut into somewhat shorter lengths).

The lengths of bamboo were placed four abreast and end to end in the bottom of the drills, but no serious effort was made carefully to adjust the cut ends so as to make a joint.

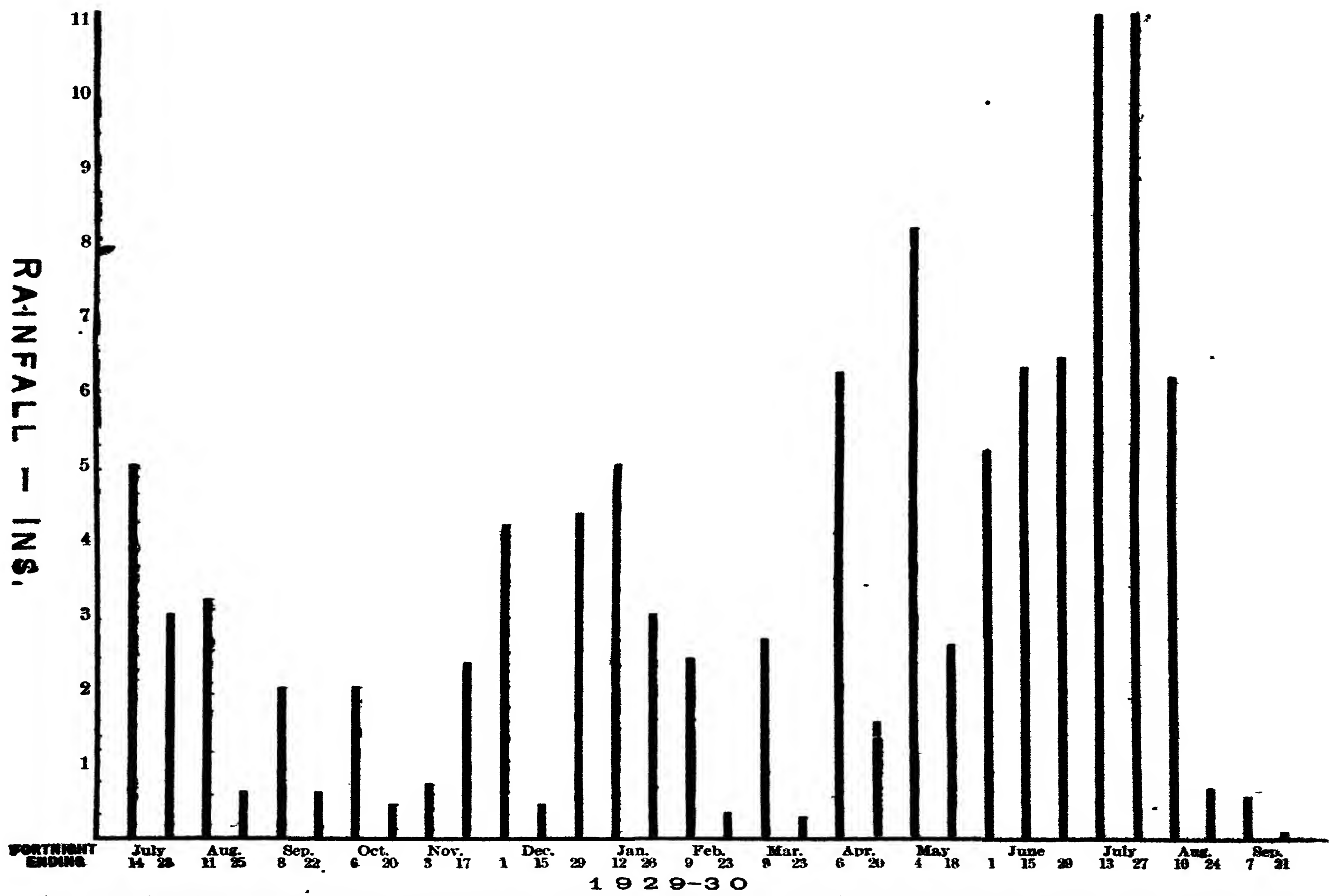
The position of the plots is indicated below:—

Control K.	Unpierced Bamboos C.	Control L.	Pierced Bamboos G.	Unpierced Bamboos D.	Piereced Bamboos H.
Pierced Bamboos E.	Unpierced Bamboos A.	Control I.	Unpierced Bamboos B.	Control J.	Pierced Bamboos F.

The perpendicular lines above indicate the position of the open drains, the bamboo drains, 10 feet apart, ran at right angles to these and opened into them. The beds used were all 'inside' beds of the field. The entire experiment was planted to D.625 and the area of each plot reaped was 0.124 acre, due care being taken to leave out several 'buffer' rows at either end of the plots. The entire experiment received sulphate of ammonia at the rate of 2 cwt. per acre and the cultural treatment was identical for all plots save that all banks (inter-rows) of the control plots were forked by hand whereas only alternate banks were forked in the bamboo-drained plots owing to the bed drill for the bamboo being on every other bank.

During dry weather water was taken into the open drains in order to help the canes as much as possible. No means of properly flooding or otherwise irrigating the field were available.

The canes were planted on July 1, 1929, and reaped on September 24, 1930. The rainfall for this period was 109.27 inches. Its distribution will best be understood by a study of the accompanying graph where it is plotted for fortnightly periods.



Fortnightly distribution of RAINFALL at SOPHIA SUGAR EXPERIMENT STATION during the period July 1, 1929—Sept. 21, 1930.

The extra expenditure involved in cutting bamboos, digging drills, etc., was :—
For the unpierced bamboo plots $41.00 per acre.
" " pierced " " $48.00 " "
However, allowing for the fact that in the bamboo-drained plots only one bank was forked, there was a saving of $5 per acre on the general cultivation of these plots and actually the figures above should be reduced to $36.00 and $43.00 respectively.

THE RESULTS.

At the reaping, the plots were weighed row by row in the field and the weights noted. The canes were not burnt before reaping. Several representative fifty-pound samples of cane were taken from each plot and passed through the experimental mills. The juices were analysed by members of the Chemical Division of the Department of Agriculture. The following table summarises the results:

Treatment.	Yield of Cane per Acre, Tons.		Juice from Mills giving 55% Extraction.		Yield of Sucrose per Acre, Tons.
			Purity.	% Sucrose.	
Unpierced Bamboos	(a)	45.41			
	(b)	39.63			
	(c)	37.02			
	(d)	32.03			
MEAN :		38.52	78.75	12.35	2.65
Pierced Bamboos	(e)	35.00			
	(f)	38.00			
	(g)	28.07			
	(h)	33.76			
MEAN :		33.71	80.10	12.76	2.40
Control	(i)	17.47			
	(j)	12.34			
	(k)	20.94			
	(l)	17.12			
MEAN :		16.97	84.70	14.31	1.30

CONCLUSIONS.

1. There was a very definite increase both in weight of cane and final yield of sucrose in favour of the plots underdrained with bamboos.

2. The increased output of the underdrained plots as plant canes repaid the cost of the underdraining (sugar being quoted at $45.00 per ton, c.i.f., at the time of writing); thus any continuation of the increase in the ratoon crops will yield profits.

3. The increased yields appear to have been due partly to the drainage effect and partly to the more efficient irrigation enjoyed by the underdrained plots since, as explained above, water, taken into the open drains in dry spells, could find its way under the beds and so to the root systems of the crop.

4. The purity and sucrose content of the juices from the underdrained plots were not as satisfactory as the corresponding figures for the controls; this appears to be due to the plots having been reaped during a dry spell when water had to be kept for several weeks in the general drainage system of the Station. This water had access to the roots in the underdrained beds and maintained growth.

5. The general yield of the field was low for plant canes, especially the yield of the control plots. It is evident that the field, in common with the whole West section of the Station, is in a low state of fertility, the contributing factors for which are: want of proper tillage owing to lack of mechanical implements, continuous cropping to cane for ten years, low organic matter content of the soil, high acidity and lime requirement, stiff texture and lack of flood-fallowing.

6. There was no marked difference in the yield of sugar from pierced and unpierced bamboo plots as plant canes.

The results of this preliminary test have been sufficiently encouraging to warrant the laying down of a more elaborate experiment involving controls, unpierced bamboos, pierced bamboos, open bed drills 2 feet deep and one foot wide, and open bed drills 1 foot deep and 1 foot wide. This has been set out in Field 9 West in the form of two latin squares.

In view of the marked effect of the bamboo drains and of the paramount importance of thorough drainage in cane husbandry in British Guiana, however, it is felt that a very useful purpose would be served if an experiment could be established on a typical sugar estate where conditions of tillage, irrigation, flood-fallowing, etc., are better than in the Sophia West Section. The writer would gladly

co-operate with any sugar estate manager in the planning and execution of such a trial.

The test in Field 4 West Sophia will be continued as ratoons.

ACKNOWLEDGEMENTS.

My best thanks are extended to the Chemical Division of the Department of Agriculture and the Staff of the Sugar Experiment Station for their cooperation.

MODIFICATIONS IN THE REARING AND DISTRIBUTION OF EGG PARASITES OF *DIATRAEA* IN BRITISH GUIANA.

BY

L. D. CLEARE, JR., F.L.S., F.E.S.

Entomologist, Department of Agriculture, British Guiana.

The method of rearing the egg-parasites of *Diatraea*, *Trichogramma minutum* Riley, and *Prophanurus alecto* Cwfd., devised by the writer and described in Bulletin of Entomological Research, (3) and reprinted in this Journal (3) has, in the course of its use, been modified to some extent by Messrs. H. W. B. Moore and H. E. Box, and it would appear desirable to place on record the nature and extent of these modifications. The modifications made by Moore involve, firstly, the oviposition by the moths, and, secondly, the parasitism of the eggs, while those of Box concern only the parasitism of the eggs; they will be dealt with now in detail.

In the method used by Moore oviposition by the moths is carried out in wire-screen cages, somewhat after the pattern of the circular cages described by the writer (*loc. cit.*, p. 34) but with this difference that in the cages used by Moore there is a wire-screen lid as well. This lid consists of a circular piece of wire-screen of the same type as used in the other part of the cage and of the same diameter as the cage, either sewn or otherwise attached to a square of cloth a few inches larger than the diameter of the cage. In use it is simply placed on the top of the cage and tied in position by means of a string passed around the cage and over the cloth, which falls naturally around the upper part of the cage. In these cages only dry cane leaves ("trash") are used, and oviposition takes place on these.

As regards the parasitism of the eggs, Moore has dispensed with the Parasite Rearing Boxes (*l.c.*, pp. 35–36), and in their place uses large drinking glasses (1-pint tumblers) about 5½ inches high, with a diameter of 3¼ inches, covered with a piece of paper held in place by means of a string. In these glasses strips of dried cane leaves bearing egg-masses are placed, the strips being placed erect in the glasses, with a suitable number of parasites for oviposition.

In order to accomplish this, some days previous to the time when the parasites will emerge the parasitized egg-masses are placed in the glasses covered with paper as described, and on the emergence of the parasites the pieces of leaves bearing the egg-masses for parasitism are inserted. To prevent the parasites escaping while this is being done, the paper is sharply tapped to cause any parasites that

may be at the top to fall. The paper cover is then quickly raised, the cane leaves bearing the egg-masses inserted, and the cover again tied in place.

In distributing the parasites in the field Moore has used methods somewhat different also from those employed by the writer (2). These have varied from time to time but two methods are used regularly now.

In one of these methods in which the parasites are liberated directly into the fields the parasites are allowed to emerge in the glasses in the laboratory and are taken to the field in these. This method is used only on fair days, and should there be any indication of rain the glasses, instead of being placed erect in the fields, are laid on their sides with their openings away from the direction of the prevailing wind.

In the other method the parasitized egg-masses are distributed in the fields in suitable containers for the subsequent emergence of the parasites. The parasitized egg-masses, with an attached piece of leaf, are placed in a 4-oz. circular cigarette tins which are hung, with the open ends up and by means of hooks about one inch long, beneath pieces of galvanised iron sheet about 7 inches square attached to light bamboo rods placed in the field. The bamboo rods with their attachments are then placed erect either in one of the larger drains (4ft. drains) or at the edge of one of the cross canals, or even in a dry drain provided grease is smeared near its base to keep off ants. In hot weather it may be necessary to protect the galvanised iron sheets with a layer of dry trash tied over them, and the tins containing the egg-masses may need a similar protection.

Two other methods have been used by Moore on other occasions for the distribution of parasitized egg-masses, and, although no longer employed, they may be mentioned here. One of these is somewhat similar to the second method described above, but in this instance the parasitized egg-masses are placed in cigarette tins which are inverted into cylindrical containers made of mosquito wire-screening attached to light bamboo poles and placed in the field as described above. The parasites on emergence escape through the mesh forming the bottom of the cylindrical containers. This method was abandoned because the parasites appeared to remain inside the tins for too long a time after emergence.

With the other method the parasitized egg-masses are distributed about the fields by the insertion of the parasitized egg-masses with their attached pieces of leaf in slits cut in the underside of the midribs of the cane leaves. Adjacent leaves that might be blown against the egg-masses are cut back as is also the end of each leaf on which an egg-mass is placed, as a precaution against over-shaking, and as an aid in locating their position for purposes of checking. This method was discontinued on account of the time consumed in placing a larger number of egg-masses.

In all these methods of distributing parasitised egg-masses, the egg-masses are not put out in the fields until the day before the parasites are expected to

emerge, in order that as little as possible opportunity may be given to ants and other enemies of finding them.

Mr. Moore has used these modifications for several years now on the sugar estates on which he is engaged, and states that they are very efficient, having also the advantages of cheapness, simplicity and ease of working.

The modification of Box did not involve the changing of the apparatus, but was rather in the nature of an addition. In his work the parasite rearing boxes were raised on an A-shaped rack which allowed of their better orientation as regards light falling on the egg-masses within, and it was claimed that by doing this a more even distribution of parasitism among the egg-masses was obtained.

While in British Guiana, Box also devised methods which were used in conjunction with the rearing of egg-parasites, for conserving the larval parasites obtained from the fields by borer gangs, such as the erection of a parasite room with a light-trap, and these have been dealt with elsewhere (1) (3).

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NOTES.

An Analysis of Pasture Grasses of the Colony:—A large sample of Guatemala Grass (*Tripsacum* sp.) was forwarded for analysis by the Government Veterinary Surgeon. The grass had been grown on the heavy coast clay of the Government Stock Farm. The sample was divided into two parts. One sub-sample consisted of the whole leaves while the other consisted of leaves from which the mid-rib had been removed. The samples were examined as to their content of moisture, ash, silica, lime and phosphate. The results obtained are appended.

Ash Analysis of Guatemala Grass.
Percentage on Oven-dry basis.

	Whole leaves	Leaves without mid-rib
Total Ash	10.10 ...	10.01
Silica	6.40 ...	5.83
Silica-free ash	3.70 ...	4.20
Lime (CaO)	0.15 ...	0.13
Phosphate (P_2O_5)	0.58 ...	0.35
Nitrogen	1.03 ...	1.01

The total ash content is of an average quantity. The silica-free ash content is low when compared with other grasses grown at the Stock Farm (*Agr. Jour. B.G.* III., p. 151). The silica content of the ash of both samples is high. The lime content of both samples is very low and compares unfavourably with other coastal samples examined. The phosphate content of the whole leaves is higher than that of the majority of the other pasture grasses of the Stock Farm: it is, however, inferior to that of the natural pastures of Great Britain. The phosphate content of the leaves without mid-ribs is markedly lower. A considerable amount of the phosphate appears to be concentrated in the mid-rib. It is apparent that whole leaves of Guatemala grass should be fed to the animals.

During a recent visit to the North West District, samples of Wynne Grass (*Melinis minutiflora*) growing at the Wauna sub-station were obtained. The sandy soil at Wauna is typical of large areas of the interior. It has perhaps not been subjected to so much leaching as the soils occurring at the Waranama Ranch, Berbice River, but the two soils are of the same type. Wynne Grass at Wauna grows rapidly and covers the ground well. Some difficulty is experienced in keeping it under control when other crops are being cultivated. The mineral content of such a grass is therefore of the greatest interest to stock-farmers of the interior. The results of analysis are here appended.

Ash Analysis of Wynne Grass
Percentage on Oven-dry basis

Total ash ...	5.44
Silica ...	1.57
Silica-free ash ...	3.87
Lime (CaO) ...	0.48
Phosphate (P_2O_5) ...	0.26
Nitrogen ...	1.38

Comparison of these figures with those previously reported for grasses of the Waranama Savannah shows that the sample contains more silica-free ash than the savannah grasses (with the exception of the introduced Para Grass). Wynne Grass, grown at Wauna, contains considerably more lime and phosphate than do the grasses of the Waranama savannah. It does not, however, compare in these respects with the natural pastures of Great Britain.

It is probable that the soil of Wauna sub-station is in a slightly higher state of fertility than the soils of the Waranama savannah. It would, however, be of great interest to attempt to establish Wynne grass on the open savannah at Waranama and to examine samples of the grass in regard to their mineral matter content.

Much depends upon the palatability of Wynne grass. It is understood that trials in this direction are being carried out at the Government Stock Farm.

R.R.F.S.

Aid from the Colonial Development Fund :—The Department has to acknowledge the receipt of the below mentioned aid for the Colony's rice industry from the Colonial Development Fund :

(1) \$8,160—To meet the cost of the erection of paddy seed barns and the purchase of weighing machines for five district stations—to be offset by an equivalent free grant.

(2) \$3,840—To provide a revolving fund for the purchase and distribution of seed—to be offset by an equivalent amount in the form of a loan free of interest repayable at the end of five years from the date of issue.

(3) \$12,240—To meet the cost of the salary of a Plant Breeder for a period of three years at the rate of \$4,080 per annum—to be offset by an equivalent free grant.

Definite trials with pure line paddies are already being carried out in each county and the variety giving the best results will be multiplied for seed supply in ten-acre blocks worked by farmers under the immediate control of the Agricultural Superintendents.

The seed thus obtained will be first distributed to selected private seed farms in each district for further multiplication under the guidance of the Agricultural Superintendents. Government Certificates will be issued for the purity of the seed—on condition of course that the instructions of the Agricultural Superintendents have been carried out—which should secure a higher price for such seed. Normally, the cultivator is in need of ready cash at harvesting time and must of necessity dispose of his entire paddy crop; the revolving fund made possible by the loan, will enable purchases of the pure seed grown to be made at harvest and supplies held for the convenience of growers, thus ensuring that the bulk of the seed intended for sowing the next season's crop will not be sold to millers. In this way, a guaranteed

selected pure seed supply will be built up, and it is hoped that from the third crop after the commencement of this scheme there will be sufficient pure seed available to plant up the whole of the rice area of the Colony, the ten-acre blocks being regularly used as a nucleus for maintaining purity.

This aid will now enable the Department to provide regular and abundant supplies of selected seed to rice growers throughout the Colony, and thus assist very significantly in the standardisation in the quality of Demerara Rice.

The Department also desires to record its gratitude for financial aid which has been granted by the Empire Marketing Board for the prosecution of research on the control of the Small Moth-Borers (*Diatraea* spp.) of Sugar Cane. It may be mentioned that this is the only serious insect pest of sugar-cane in British Guiana, but infestation by this borer is higher here than in any other country from which records have been received.

Mr. L. D. Cleare, Jr., F.L.S., F.E.S., Entomologist to this Department, will be seconded for 3 years for investigation into the biological control of the pest. A qualified Supernumerary Entomologist is being appointed on the staff of the Department for this period. This will be possible only through the assistance given by the Empire Marketing Board.

J.S.D.

Agricultural Machinery:—For general information, it seems advisable to draw attention to the Customs Duties payable on imported machinery.

Agricultural machinery (including parts, accessories and appliances) of British manufacture may be imported free of duty.

Agricultural machinery of other manufacture is liable to duty at the rate of 7 per cent. *ad valorem*. If, however, the Governor-in-Council is satisfied that machinery of a like nature and quality cannot be obtained from the British Empire, exemption from duty may be granted.

All persons who contemplate the importing of agricultural machinery will therefore be well advised to obtain their requirements, whenever possible, from countries within the Empire. The Department will be very willing to give advice to persons desirous of making any such importations.

J.S.D.

Rice Grading Regulations:—The grading operations came into force on October 1, 1930, and it was found by experience that it was advisable to make certain adjustments in the descriptions and classifications of certain of the original grades of rice (See *Agr. Jour. of B.G.* Vol. III, p. 187).

The more important changes to which it is desired to draw attention are:

(1) That provision is made for a "No. 3" grade (with not more than 50 broken grains and with no colour standard),

(2) That the "Ungraded" class is abolished, as it was conceived that this classification permited foreign importers to contend that there was still a Demerara Rice on the market which lowered all standardisation and destroyed much of the advantage of grading.

(3) That provision is made for a "broken" grade in addition to a "Super broken."

(4) That provision is made for two qualities (instead of one) of white rice. The additional minor changes made can be seen below in the revised schedule which came into force on February 1, 1931.

Class	Description	Colour
Whole grain super ...	Not to exceed more than a total of 5 per cent. of broken & discoloured grains.	As per guide sample
Super	Not to exceed more than a total of 12 per cent. of broken and discoloured grains.	do.
No. 1.	Not to exceed more than a total of 25 per cent. of broken and discoloured grains.	do.
No. 2.	Not to exceed more than a total of 40 per cent. of broken and discoloured grains.	do.
No. 3.	Not to exceed more than a total of 50 per cent. broken grains. No fixed colour standard.	...
Super broken ...	Same colour standard as whole grain super or super; containing more than 50 per cent. broken grains.	...
Broken	Any colour below super; containing more than 50 per cent. broken grains.	...
White Rice—Quality A ...	To be dry reasonably clean, white and to contain not more than 5 per cent. of discoloured grains (Grains may be of irregular size and broken).	As per guide sample
White Rice—Quality B ...	To be dry, reasonably clean, white; containing more than 5 per cent. of discoloured grains. (Grains may be of irregular size and broken.)	do.

H.D.H.

Demerara Primrose:—The plant, known locally as the 'Demerara Primrose,' which has been referred to lately in several articles in this Journal on account of its value as a fodder crop, has recently been identified by the authorities at Kew as *Asystasia gangetica* (L) T. And., and is not *A. scandens*, as it has hitherto been named in the aforementioned articles.

E.B.M.

DEPARTMENTAL NOTES.

Mr. C. S. Webb, a Collector of the London Zoo who is particularly interested in rare birds, paid a visit to the Department on December 17, 1930.

Mr. L. D. Cleare, Entomologist, returned from leave on December 14, 1930, and resumed the duties of his office. While on leave Mr. Cleare attended the Third Imperial Conference held in London in June, 1930, as the official delegate of British Guiana. Mr. Cleare spent the period October 18 to December 14 at the Imperial College of Tropical Agriculture, Trinidad, investigating certain parasities (of Small Moth-Borers of Sugar-cane) which occur in that island.

Mr. C. L. C. Bourne, Assistant Chemist of this Department, returned to the Colony on December 13, 1930, after 6 months' leave of absence. While in the United States, Mr. Bourne took the opportunity to visit the New Jersey Agricultural Experiment Station, the Lederle Bacteriological Laboratories, the Boyer Thomson Institute for Plant Research and Columbia University and in Barbados visited the Laboratory and Experiment Station of the Department of Agriculture.

Mr. E. Beckett, Agricultural Superintendent, North West District, left for England on December 27, 1930, on 6 months' leave of absence. In consequence, Mr. J. D. Gillespie, Agricultural Superintendent, West Demerara, was temporarily transferred to the North West District and Mr. H. D. Huggins, Assistant Agricultural Superintendent, Demerara, was appointed to act as Agricultural Superintendent of West Demerara and Chairman of the Co-operative Credit Banks in the district.

The Director of Agriculture accompanied His Excellency the Governor and Sir W. Beveridge, K.C.M.G., C.B., D.S.O., on a visit to the Essequibo Coast from January 10 to 15. Meetings of rice millers and growers were held along the Essequibo coast and the opportunity was taken to discuss general sanitation of, and a pure water supply for the settlement area at Bush Lot.

Major T. Bone, Veterinary Surgeon, left Headquarters on January 15 for a three months' tour of the Rupununi cattle ranching district for the purpose of collecting information on certain problems of the livestock industry.

Miss J. Pestano, 6th Class Clerk of this Department, who, it was previously stated, left for Canada on June 30, 1930, on six months' leave of absence, resigned her post as from January 15, 1931. Miss Pestano was appointed Clerical Assistant on February 26, 1924, and during her association with the Department proved herself to be a very capable and efficient officer.

Mr. R. R. Follett-Smith, Chemist-Ecologist, went to Trinidad on February 12 on two weeks casual leave of absence. While in Trinidad, Mr. Follett-Smith took the opportunity of conferring with the Chemical Division of the Imperial College of Tropical Agriculture with regard to the soil experimental work of this Colony.

Members of the English Schoolboys' tour visited the Botanic Gardens and the Sugar Experiment Station on March 7 and were afterwards guests of the Director.

Messrs. W. Gaskell, C.I.E., and D. S. Macgregor, C.B.E., F.S.A.A., paid a visit to the Department on March 10, and were shown over the Botanic Gardens, the Rice Station and the Sugar Station by the Director on the afternoon of March 12.

It is with regret that the death of Mr. Arthur Earnest Hicks Bratt, which took place on March 12, is recorded. Mr. Bratt started life as an overseer at Pln. Bath, Berbice, over thirty years ago and later occupied the positions of Deputy Manager, Pln. Diamond; Manager of Pln. Providence (Demerara) and Manager of Pln. Leonora, where he remained for 10 years. At the time of his death he was Manager of Pln. Ruimveldt. The Colony has lost in Mr. Bratt a most able and experienced sugar planter.

The Department sent 5,000 cartons of super grade rice and 2,500 copies of a Spanish edition of the Brochure "Buy Demerara Rice" to Buenos Aires to be distributed during the British Empire Exhibition which opened on March 14.

Mr. F. C. Harding, Supervisor of the Royal Bank of Canada in Trinidad, very generously consented to forward these samples and literature to the Buenos Aires branch of the Royal Bank which will be responsible for the distribution of this material to those persons and businesses likely to evince most trade interest in Demerara Rice.

Prof. R. B. Thomson, Professor of Botany, University of Toronto, Canada, arrived in the Colony by C.N.S. "Lady Hawkins" on March 19; and visited the Department on the same date.

The Director, Deputy Director and Assistant Chemist visited Pln. Ogle (East Coast) on February 10 in connection with ascertaining the suitability of some the front lands of the estate for market-garden crops.

During the period under review The Deputy Director paid visits of inspection to Bush Lot (on two occasions), Nos. 1 and 2 Canals Polder, W. B., Demerara, and certain of the sugar estates on the East Coast.

Mr. R. R. Follett-Smith, Chemist-Ecologist, visited Plns. Non Pareil, Enmore, Uitvlugt, Tuschen, Turkeyen, Cane Grove, Bartica Road and the upper reaches of the Demerara River.

Mr. C. H. B. Williams, Sugar Cane Agronomist, paid visits to Plns. Uitvlugt, Leonora, Diamond, Farm, Lusignan, Cane Grove, Blairmont, Rose Hall, Albion, Port Mourant and Skeldon. Several visits have been paid to some of these estates, notably Port Mourant, Blairmont, Lusignan, Farm and Uitvlugt. Extensive manurial experiments have been started at Port Mourant and Farm, and a fertilizer trial has been reaped at Uitvlugt. The Cane Agronomist also visited cane farmers' lands at Beterverwagting and Buxton.

Mr. E. B. Martyn, Botanist and Mycologist, visited Pln. Waterloo, Nickerie, from January 24-25, to observe the extent of Mosaic Disesea on the cane of the estate. From February 21 to March 15 he accompanied the Forestry Survey party on the Cuyuni River, and was engaged in collecting plants and carrying out some ecological work in co-operation with the officers of the Forestry Department.

Prof. J. S. Dash, Director of Agriculture, left the Colony on March 24, for Canada, *via* New York, on 6 months' leave of absence. It is hoped that Prof. Dash will attend the Conference of Directors of Agriculture to be held in London in July. Mr. F. Burnett has been appointed Acting Director of Agriculture for this period.

PLANT AND SEED IMPORTATION.

THE FOLLOWING ARE RECENT INTRODUCTIONS BY THE DEPARTMENT OF AGRICULTURE.

Description	Quantity	Whence Received
Economic.		
Cowpeas	1 lb.	U.S. Department of Agri.
Papaw	3 ozs.	Montserrat
Jute	2 lbs.	Imperial College of Tropical Agriculture, Trinidad
Garrick seed corn	1 lb.	Bureau of Plant Industry, U.S. Dept. of Agriculture
Whatley seed corn	1 lb.	do.
Budwood.		
Valencia	250 buds	Department of Agriculture, Trinidad.
Parson Brown	500 „	do.
Navel	250 „	do.
Marsh	700 „	do.
Marsh	2,000 „	Mr. W. S. E. Barnardo, Trinidad
Marsh seedless	1,000 „	Agricultural Superintendent, Dominica
Duncan	1,000 „	do.
Ornamental		
Orchids	1 Box	Canal Zone
Bletia purpurea		
Camaridium ochroleucum		
C. latifolium		
Sobralia Bouchei		
Trichophilia maculata		
Trigonidium Seemani		
Sesame	1 packet seed	Director of Agri., Ceylon
Attalaea spinosa	6 seeds	Botanic Gardens, Singapore.
Calyptrocalyx spicatus	1 tin seeds	do.
Cinnamomum Camphora	6 roots	Gold Coast, W. Africa
Cinnamomum Zeylanicum	1 packet	do.
Gloriosa superba	6 roots	do.
Strelitzia Reginae	1 packet	do.

DESCRIPTION.	QUANTITY.	WHENCE RECEIVED.
Orchids	1 Box	
Aspasia epidendroides		Adrien M. Bauché, Esq., Canal Zone
Aspasia principissa		do.
Bulbophyllum vinosum		do.
Catasetum scurra		do.
Cattleya Deckeri		do.
Cycnoches Dianae		do.
Cypripedium longifolium		do.
Dichea panamensis		do.
Epidendrum atropurpureum		do.
E. difforme		do.
E. Stamfordianum		do.
Eulophia alta		do.
Hexisia bidentata		do.
Ionopsis utricularioides		do.
Lycaste Powellii		do.
Lockhartia mirabilis		do.
L. pallida		do.
Mormodes atropurpureum		do.
Oncidium confusum		do.
O. ochmatochilum		do.
O. panamensis		do.
O. sp. (cerocroprum?)		do.
Ornithidium anceps		do.
Peristeria elata		do.
Sobralia Bouchie		do.
S. epiphytica		do.
S. panamensis		do.
Stanhopea bucephalus		do.
Trichopilia sp.		do.

EXPORTS OF AGRICULTURAL AND FOREST PRODUCTS.

Below will be found a list of the Agricultural and Forest Products of the Colony exported during 1930.

The corresponding figures for the same period during previous years and the average for the eleven years prior to that are added for convenience of comparison.

Product		*Average 1907-27*	*1928*	*1929*	*1930*
Sugar	tons	97,875	114,687	100,449	114,542
Rum	proof gallons	2,279,375	1,269,923	1,109,482	846,319
Molasses	gallons	439,432	2,873,468	2,536,623	3,851,337
Molascuit	tons	3,684	2,082	1,803	400
Rice	tons	6,544	18,083	14,091	22,480
Coconuts	thousands	1,561	322	638	629
Coconut Oil	gallons	22,730	26,244	20,862	26,377
Copra	cwts.	5,627	70,017	75,187	40,200
Coffee	cwts.	3,311	8,212	8,098	3,280
Lime Juice Concentrated	gallons*	9,227	8,124	12,717	11,373
Essential Oil of Limes	gallons*	348	440	801	660
Rubber	cwts.	91	143	15	46
Balata	cwts.	10,115	5,782	5,356	8,888
Gums	lbs.	2,531	1,674	707	1,010
Firewood—Wallaba, etc.	tons	7,972	10,054	9,369	11,796
Charcoal	bags	55,926	46,374	51,593	51,537
Railway sleepers	No.	12,572	18,873	13,591	3,375
Shingles	thousands	2,229	2,156	2,424	1,587
Lumber	ft.	219,740	195,773	117,802	175,228
Timber	cu. ft.	183,988	134,044	435,888	181,206
Cattle	Head	576	503	966	1,336
Hides	No.	5,667	7,146	7,312	6,423
Pigs	No.	682	457	385	869
Sheep	No.	55	2	None	4

*An average of twelve years, 1916 to 1927.
No records available prior to 1916.

CURRENT PRICES OF COLONIAL PRODUCE.

From The Commercial Review, Journal of the Georgetown Chamber of Commerce, Vol. XIV, No. 8, May, 1931.

SUGAR.

Per 100 lbs. net   3 lbs. per Bag allowed for tare

Dark Crystals for Local Consumption..................$2.80
Yellow Crystals do. do. $3.50
White Crystals..$4.25 to $4.35
Molasses Sugar...... ....none offering

RUM.

Imperial Gallon.   Cask included.

Coloured, in Puncheons—40 to 42 O.P...(for export).....60c. Hhds. 65c. Barrels 70c.
White, in Hogsheads—10 to 45 O.P...(for local consumption)...........48 to 55c.

MOLASSES.

Per Imperial Gallon.   Cask included.

Yellow (firsts).. }
Yellow (seconds)...................................... } None Offering
Dark.. }

RICE.

Rice............per Bag of 180 lbs. gross, $2.60 to $4.25 as to quality.
Paddy..........per Bag of 143 lbs. gross, $1.08 to $1.50

GENERAL.

Gold, Raw,..per oz. $18 to $20.
Diamonds,—pro rata as per quality.......................average per carat $13 to $14.
Timber, Gr. Heart, (Lower grade measurements)···72c. to 96c. per c. ft., for export $1.00 to $1.20 per c. ft.
Do. Railroad Sleepers—(Mora)..$1.68 each
Greenheart Lumber...$110 per 1,000 feet
Crabwood Lumber ....$60 to $75 per 1,000 feet
Shingles, Wallaba, 4 x 20 and 5 x 22 inches,.......................$7.00 to $9.00 per M.
Charcoal, Capped for shipment...$1.00 to $1.20 per Bag
Firewood...$3.00 to $3.50 per ton
Coconuts........ Selects, $18.00, culls......$10.00 M ....Copra, 3¼c. per lb.
Balata...............................Venezuelan, none. Local Sheet...38 to 40 cts. per lb.
Cocoa...14c. " "
Coffee...3½c. " "

N.B.—Duty payable on value at time of Importation and at Rate of Exchange on day of arrival.

METEOROLOGICAL DATA, 1930.

BOTANIC GARDENS, GEORGETOWN.

1930. MONTHS.	Rainfall. Inches.	Number of Days of Rain. Under 10 in.	.10 to .50 in.	.50 to 1.00 in.	1.00 to 2.00 in.	Above 2.00 in.	Total Days.	Evaporation. Inches.
January	8.24	5	17	...	2	1	25	3.86
February	3.70	8	5	1	1	...	15	5.18
March	1.10	7	5	...	...	...	12	6.76
April	9.60	5	9	3	2	1	20	5.62
May	12.94	6	12	3	1	2	24	4.07
June	12.62	7	11	7	2	1	28	2.87
July	21.02	5	7	6	4	3	25	3.61
August	4.59	1	4	2	2	...	9	6.17
September	.62	2	2	...	...	...	4	7.28
October	1.70	1	4	1	...	...	6	7.18
November	1.14	2	2	1	...	...	5	7.24
December	7.60	4	8	3	1	1	17	5.01
TOTALS	84.87	53	86	27	15	9	190	64 85

AIR TEMPERATURE AND HUMIDITY IN THE SHADE BOTANIC GARDENS, GEORGETOWN, 1930.

Months.	Air Temperature.			Humidity.
	Maximum.	Minimum.	Mean.	Mean.
January ...	82.2	74.6	78.4	84.8
February ...	82.9	74.7	78.8	79.2
March ...	84.5	75.9	80.2	78.9
April ...	84.6	75.9	80.2	80.6
May ...	84.1	75.9	80.0	84.7
June ...	84.1	75.1	79.6	85.1
July ...	84.1	75.2	79.6	85.0
August ...	86.1	75.8	80.9	80.9
September ...	87.9	76.2	82.0	78.1
October ...	88.0	76.6	82.3	78.4
November ...	88.6	77.8	83.2	75.1
December ...	86.1	76.5	81.3	79.5
Mean ...	85.3	75.8	80.5	80.9

WETTEST AND HOTTEST DAYS AT VARIOUS STATIONS.

Stations.	Wettest Day.	Rainfall Inches.	Hottest Day.	Temperature. in shade
Botanic Gardens, Georgetown ...	16th July.	3.68	21st Nov.	90.5
New Amsterdam Public Gardens ...	13th July	3.81	3rd Sept.	93.0
Onderneeming, Essequibo ...	5th July	3.98	23rd Nov.	91.0
Morawhanna, N.W.D.	4th Dec.	3.60	...	...

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BRITISH GUIANA.

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Field Assistant	B. A. MacArthur

In collaboration with the Officers of the Department of Agriculture.

CONTENTS.

(Vol. IV, No. 2.)

LIST OF ILLUSTRATIONS.

The

Agricultural Journal of British Guiana.

June, 1931.

EDITORIAL.

ELEMENTARY AGRICULTURAL TRAINING CENTRES.

In order to enlist the enthusiasm of boys in some of the problems of farming and to stimulate the need for agricultural experience in formative years, the Department of Agriculture proposes to inaugurate, at an early date, a limited number of agricultural allotments at selected villages throughout the Colony. Investigations are now being made by the Divisional Officers to obtain suitable sites. On such allotments, boys from the age of 12 or young men interested in agriculture will have the opportunity of obtaining a practical training in elementary agriculture. Each student will be required to cultivate a small allotment under the direction of the Agricultural Superintendent of the District; instructions will be given at definite times during the gardening season, probably twice weekly, at times to be arranged at each centre.

At the outset the number of centres will, to a very large extent, depend on the availability of suitable land—*i.e.*, whether or not Government land can be obtained or whether it will be possible to obtain grants of free land for such purposes. The area to be required at each centre will depend entirely on the number of boys or students that will attend, but, as the size of each individual plot to be allotted will not exceed 1/40th of an acre and probably will be even smaller, an area of one acre should suffice at the beginning.

On such allotments the pupils will be taught the best practices in :—

(1) Methods of establishing and laying out a vegetable garden and systems of drainage that should be employed.

(2) Elementary acquaintance with the different soil types, the differences in their behaviour and their relationship to plant growth.

(3) Demonstrations in and practice of common agricultural practices such as forking and the preparation of vegetable garden beds.

(4) A knowledge of nursery practices such as the preparation of nursery boxes and seed beds, the planting of seeds and the care of young seedlings.

(5) Acquaintance with names and general requirements of economic plants.

(6) Elementary horticultural practices such as budding, grafting, layering.

(7) Care of young vegetatively propagated plants.

(8) Acquaintance with the names and requirements of common ornamental plants.

(9) Care of ornamental plants.

The produce from such gardens will be the property of the students.

The initial outlay of commencing such a scheme will be the cost of gardening implements, fencing material, a tool shed for the storing of such implements and prizes for attendance and for the best allotments. Such costs can be considerably reduced if the students provided their own gardening implements, etc. It might be advisable to have barbed wire fencing, although a well constructed cross stick fence will not only provide a practical lesson in fencing, but should be generally efficient.

As the scheme progresses it is hoped to give lessons in bee-keeping, and to keep hives of bees at each centre. It will not be possible at the outset to keep poultry or livestock at such centres as these will require daily supervision and food, and naturally can only be kept at the students' homesteads. The methods to be employed in promoting interest in the care of livestock will in the first case require a considerable amount of ground work and as gardening is taught by practical methods, arrangements will be made for demonstrations to be given on livestock of all kinds at each centre. The activities of enthusiastic students can then be extended.

ORIGINAL ARTICLES.

MANURIAL EXPERIMENTS WITH SUGAR CANE II.

1. BLAIRMONT (FIELD B. L. 47)

BY

C. HOLMAN B. WILLIAMS, D.I.C.T.A.,

Sugar Cane Agronomist, Department of Agriculture, British Guiana.

INTRODUCTION.

The principal object of this experiment was to determine the value of Kerazotine and Leathermeal, two nitrogenous organic manures, in comparison with sulphate of ammonia.

The experiment took the form of a Latin Square with seven treatments and seven replicates of each treatment. The arrangement of the plots, methods of manuring, weighing, sampling, etc., were similar to those described in this *Journal*, IV, No. 1, p. 10. The formulae tried were :—

1. No manure
2. Kerazotine at 40 lbs. Nitrogen per acre
3. Leathermeal at „ „ „ „ „
4. Sulphate of ammonia at 40 lbs. Nitrogen per acre
5. „ „ „ „ 80 „ „ „ „
6. „ „ „ „ 120 „ „ „ „ in one dose
7. „ „ „ „ 120 „ „ „ „ in two doses of 60 lb. each.

The area of each plot reaped and weighed was 0.051 acre.

Kerazotine and Leathermeal were kindly supplied free of cost by the Comptoir d'Engrais et de Matières Premières, of 142 Avenue du Margrave, Antwerp, Belgium. Their composition, etc., have already been given in this *Journal*, IV No. 1. pp. 13-14.

Sulphate of ammonia was supplied by the Estate. Its cost at the time of application was $48.62 per ton. All the plots, controls included, received a basic dressing of 2 cwt. superphosphate of lime per acre. This was supplied by the Estate, its cost at the time being $21.36 per ton. This application is not considered below as it was common to all the plots.

THE EXPERIMENT.

The experiment was carried out on plant canes of D.625 in Field B.L.47. The soil was sampled and the samples submitted to the Chemical Division, Department of Agriculture, which reports as follows :—

	Topsoil	*Subsoil*
Moisture at Point of Stickiness, per cent.	43.7	40.9
Sand, (1.0-0.04 mm. diam.) per cent.	9.9	15.3
Index of texture, ...	42	38
Normal pH.	4.2	4.3
Exchange pH, ...	3.6	3.9
Organic matter, per cent.	1.20	—
Nitrogen, per cent.	0.100	—
Carbon : Nitrogen ratio, ...	6.98	—
Theoretical lime requirement (Tons $CaCO_3$/ acre)	13.1	—
[1] Available nutrients, ...	122	87
[2] Rate of solution, ...	9	0
[3] Available phosphate, p.p.m., ...	25	28
Exchangeable bases, milligram equivalents per 100 gm. soil :		
CaO, ...	3.00	3.85
MgO, ...	1.81	1.45
K_2O, ...	0.12	0.21
Na_2O, ...	0.26	0.18
MgO : CaO Ratio, ...	0.60	0.38

The soil is a highly acid heavy silt. The subsoil, also highly acid, is slightly lighter in texture. The topsoil possesses a high lime requirement. Both topsoil and subsoil appear to contain a fair supply of readily available nutrients. The rate of solution, suggested as a measure of soil fertility, is very low. It seems improbable that the soil of the area will respond to further dressings of phosphatic manures. The amounts of available bases are very low. Exchangeable lime is present in excess of exchangeable magnesium. The topsoil contains an average amount of organic matter and the carbon : nitrogen ratio is of the order usually found in the cane soils of the Colony.

The field was tractor ploughed previous to planting. Canes were planted on January 22, 1930, superphosphate applied on February 10, and the other fertilizers on February 26. The plots whose formula required a second dose of

[1] The Specific conductivity at 28°C. of a 1:5 soil water extract, 20 hours standing, mhos x 10^6.

[2] The seven day increase in specific conductivity of the identical soil-water extract.

[3] Available phosphate determined by the Truog method (*Jour. Am. Soc. Agron.*, XXII, pp. 874-882.)

sulphate of ammonia received this on May 6, 1930. The field received the cultural treatment usually accorded by the Estate to fields of its class, and the plots were reaped and weighed on April 23 and 24, 1931.

The following table shows the average distribution of the rainfall at Blairmont and that for the duration of the experiment ;—

	Rainfall 1930-1931, inches.	Average Rainfall 1911-1930, inches.
January	9.77	8.95
February	1.63	4.63
March	3.80	4.42
April	10.50	5.14
May	9.89	10.27
June	10.83	12.29
July	18.36	10.44
August	2.49	6.58
September	1.06	2.08
October	.15	2.57
November	.56	3.69
December	6.33	9.65
January	10.00	8.95
February	9.42	4.63
March	2.67	4.42
April	6.13	5.14
Total	103.59	103.85

It will be seen that while the total precipitation was practically the same as the average, its distribution was not nearly as satisfactory as usual.

The Estate authorities have kindly supplied the following figures for the yield, etc., of the entire field.

Area	12 acres
Tons cane	389.05
Sucrose in Juice, per cent.	12.86
Purity of juice	79.42
Tons sugar, 96°	34.05
" " per acre	2.83

A Wiley bagasse mill has been installed at the Sugar Experiment Station. Since the cane is weighed on each plot and the sucrose in cane is determined by analysing both the juice and bagasse of a sample from each plot, it is now possible to express yields in terms of sucrose in cane per acre. The Management of each estate knows how much commercial sugar its plant can extract per 100 sucrose in cane and can interpret the data accordingly. However, for convenience of quick reference, the increments over the control have been converted into 96° sugar per acre by using the average extraction figure of six large local factories.

THE RESULTS.

Treatments (lb. per acre).	Nitrogen per acre, lb.	Sucrose in cane per acre, tons.	Increment over Control, Sucrose in cane per acre, tons.	Increment over Control expressed as 96° Sugar obtainable by six local factories, per acre, tons.	Value of Increment over Control, with sugar at $44 per ton, $	Cost of Manures and Application per acre, $	Profit per acre on Manuring, $
Sulphate of Ammonia 600 lb. (1)	1.20	4.14	1.49	1.26	55.44	13.42	42.02
" " " (2)	1.20	4.05	1.40	1.18	51.92	13.32	38.60
Sulphate of Ammonia 400 lb.	80	3.70	1.05	0.89	39.16	8.92	30.24
Sulphate of Ammonia 200 lb.	40	3.73	1.08	0.91	40.04	4.52	35.52
Kerazotine 290 lb.	40	3.17	0.52	0.44	19.36	9.91	9.45
Leathermeal 480 lb.	40	3.17	0.52	0.44	19.36	10.33	9.03
Control	..	2.65	...	.	...	...	...

In executing an experiment of this nature, it is impossible to eliminate entirely variations due to soil differences, weeds, drainage, personal equation of workers, and other factors. Unless, therefore the difference between the mean yields of any two formulæ is great enough to be almost certainly due to difference in treatment (e.g. chances of 20 to 1), it is not usual to draw definite conclusions therefrom. The yields of sucrose in cane per acre given above are means of seven plots of each treatment. Statistical analysis of the results indicates that any difference in the mean yields greater than 0.63 ton sucrose in cane per acre has a 20 to 1 chance of being due to difference in manurial treatment. Any such difference, *i.e.* greater than 0.63 ton sucrose in cane per acre, is considered to be statistically significant.

(1)=in two Doses.
(2)=in one Dose.

Conclusions.

On the area in question and under the conditions of the experiment :—

1. Leathermeal and Kerazotine are no more efficient than sulphate of ammonia at an equivalent dose of nitrogen, though costing more than twice as much. Indeed there was a marked tendency to higher yields from the sulphate of ammonia.

2. The increased yields given by Leathermeal and Kerazotine over the controls were not quite sufficiently high to be statistically significant.

3. Both 40 and 80 lb. nitrogen per acre, as sulphate of ammonia, gave statistically significant and remunerative increases over the controls. The average yields of the two dressings, however, were almost identical.

4. 120 lb. nitrogen per acre, as sulphate of ammonia, gave statistically significant and remunerative increases over the controls whether this heavy dose was given all at once, 34 days after planting, or in two applications, one at 34 and one at 104 days after planting. The two-dose treatment gave 2.3 tons of cane per acre more than the one dose, but the second application of the former appears to have had an adverse effect on the juice, so that there was little difference in the final yields of sucrose per acre.

5. The increases given by the 120 lb. doses over the 40 and 80 lb. treatments are not statistically significant, but, as in the case of the plant cane field at Sophia (*Ibid*, IV, pp. 13-17), there was a marked tendency for these doses to give heavier and remunerative yields.

This experiment will be continued on the first ratoons, and any residual effect that may be obtained from the organic manures, which are perhaps slower in acting than the sulphate of ammonia, will then be observed.

Summary.

An experiment on plant canes of D. 625, executed on a highly acid heavy silt at Blairmont Estate, Berbice, B.G., has demonstrated that Kerazotine and Leathermeal are not more efficient than sulphate of ammonia, at an equivalent dose of nitrogen, though costing twice as much. The further conclusion is tentatively drawn that 600 lb. sulphate of ammonia per acre will probably prove an economically sound dose for plant canes on ploughed lands in this section.

Acknowledgments.

Thanks are extended to the Chemical Division of the Department of Agriculture, for analyses of soils, manures and juices; to Mr. L. A. Forte for his help throughout the experiment; and to Messrs. H. Macluskie, E. Morgan and H. France (all of the Department of Agriculture) for assistance in taking weights, etc., at reaping.

Special mention must be made of the helpful co-operation of the Manager and Staff of Blairmont Estate.

2. SOPHIA (FIELD 12 WEST).

BY

R. R. FOLLETT-SMITH, B.Sc., A.R.C.S.,

Chemist-Ecologist, Department of Agriculture, British Guiana,

AND

C. HOLMAN B. WILLIAMS, D.I.C.T.A.,

Sugar Cane Agronomist, Department of Agriculture, British Guiana.

INTRODUCTION.

In view of the marked acidity and comparatively high lime requirement of the soils of the Sophia Sugar Experiment Station, and of large areas of the Colony's sugar belt, it was deemed advisable to lay out an experiment with the object of determining the optimum dose of pulverized limestone for a typical field on the Station.

The formulae tried were:—

1. No limestone
2. Pulverized limestone at the rate of 3 tons per acre
3. " " " " " " 6 " " "
4. " " " " " " 9 " " "
5. " " " " " " 12 " " "
6. Same as formula 4 with 0.5 tons per acre ground rock phosphate in addition.

The area of each plot reaped was 0.0413 acre. There were six replicates of each treatment arranged in a Latin Square. The shape of plot, methods of manuring, weighing, sampling, etc., were similar to those employed for the trials described already (*Ibid* IV, p. 10).

THE EXPERIMENT.

The experiment was carried out on plant canes of B. H. 10 (12) in Field 12 West. In the course of a survey of the soils of the Sophia Experiment Station[1], one of us obtained the following data for the area in which this field is situated :—

[1] FOLLETT-SMITH, *Ibid*, III, pp. 63-71.

	Topsoil Markedly acid heavy silt.	*Subsoil* Acid clay.
Moisture at point of stickiness, per cent. ...	44.00	50.1
Sand (1.0–0.04 mm. diameter), per cent. ...	8.5	6.7
Index of texture	42	49
Normal pH	5.32	6.10
Exchange pH	4.88	5.38
Theoretical lime requirement, Tons $CaCo_3$ per acre,	6.1	3.5
Available potash (1% citric acid sol.), per cent.	0.009	0.006
Available phosphate (1% citric acid sol.), per cent.	0.0015	0.0005
,, ,, (Truog method) p. p. m.[2]	30	30
Organic matter, per cent.	1.62	0.60
Exchangeable bases, milligram equivalents per 100 gms. soil:		
CaO	9.27	
MgO	19.68	
K_2O	0.54	
Na_2O	1.46	
MgO : CaO ratio	2.12	

The topsoil of the area consists of a markedly acid heavy silt with a lime requirement of 6.1 tons ground limestone per acre. It possesses an average amount of organic matter. It is to be expected from a consideration of the soil acidity and from the preponderance of exchangeable magnesium over exchangeable calcium, that dressings of limestone would have a beneficial effect upon cane growth. It appears from the figures obtained for exchangeable potash and for 'available' potash (soluble in 1 per cent. citric acid) that applications of potassic manures are not likely to enhance the yield of cane.

The phosphate status of the soil was examined, in the first place, by the extraction method, using 1 per cent. citric acid. It appeared, from the results obtained, that cane growth on the area was likely to respond to dressings of phosphatic manures. An application of rock phosphate was accordingly included in the treatments. The results here reported indicate that phosphatic manuring has had no effect upon the plant cane yield. It is possible that the ratoons may respond. It is of interest to note that the results obtained by the method described by C. L. C. Bourne in this *Journal*, indicate that the soil will not respond to applications of phosphatic manures. It is apparent that methods of advisory examination of the phosphate status of the cane soils in British Guiana require further consideration.

[2]See this number, p.p. 91—94.

The subsoil of the area is an acid clay possessing a lime requirement of 3.5 tons ground limestone per acre.

The limestone and rock phosphate were spread on the surface of the soil just before the land was prepared for planting. Tillage was done with the hand fork, the amendments being incorporated as much as possible, and the canes were planted on February 11, 1930.

The limestone used cost $11.20 per ton c. and f. Georgetown. Its composition was as follows:

Chemical analysis.		*Mechanical analysis.*	
Calcium carbonate, %	96.74	Passing 10 mesh sieve, %	99.55
Magnesium carbonate, %	0.72	„ 100 „ „ , %	60.65
Iron oxide and alumina, %	1.02		
Silicious matter, %	1.52		

The whole experimental area received a uniform application of 60 lb. nitrogen per acre in the form of sulphate of ammonia.

The rock phosphate used can be purchased in lots of 150 tons at $17 per ton, f.f.a. Georgetown. Its composition is as follows:

Chemical analysis		*Mechanical analysis*	
Phosphoric anhydride, %	36.6	Passing 10 mesh sieve, %	100
		„ 100 „ „ %	80.7

The usual cultural treatment was given the canes. The general growth was not very good. This is attributed partly to the infertility of the soil, which needs resting, flood-fallowing and/or mechanical tillage; partly to the small application of sulphate of ammonia, the dose being kept low in order that the effect of the limestone would not be masked; and partly to the unfavourable weather conditions which prevailed. As will be seen from the table below, the rainfall for the period August 1930 to April 1931 amounted to just half the average.

	Rainfall, 1930-1931, inches.	Average Rainfall, 1921-1930, inches.
February	3.69	3.76
March	0.90	3.89
April	10.38	4.41
May	13.89	11.67
June	12.96	14.86
July	22.76	10.98

		Rainfall, 1930-1931 inches.			Average Rainfall, 1921-1930, inches.	
August ...	...	6.19			8.50	
September	...	0.99			3.07	
October	...	1.37			3.64	
November	...	1.60			6.68	
December	...	8.94	28.20	...	14.78	56.34
January	...	2.13			7.61	
February	...	3.58			3.76	
March ...	...	2.17			3.89	
April ...	...	1.23			4.41	
May ...	...	11.66			11.67	
Total		104.44			117.58	

The plots were reaped and weighed on May 20, 1931. Sucrose in cane was determined by analysing both juice and bagasse of a sample of cane from each plot, and the results calculated to tons sucrose in cane per acre.

THE RESULTS.

Treatments (Tons per acre)	Sucrose in cane, per acre Tons	Increment over Control, Sucrose in cane, per acre Tons	Increment over Control Expressed as 96° sugar obtainable by Six local factories, per acre Tons	Value of Increment over Control with sugar at $44 per ton $	Cost of Amendments and Application, per acre $
Ground Limestone 12	2.50	1.58	1.33	58.52	152 40
" " 9	2.48	1.56	1.32	58.08	114.30
" " 9 and Rock Phosphate 0.5	2.30	1.38	1.16	51.04	123.55
Ground Limestone 6	2.09	1.17	0.99	43.56	76.20
" " 3	1.78	0.86	0.73	32.12	38.16
Control ...	0.92	...	...	...	...

Any difference between the mean yields greater than 0.34 ton sucrose in cane per acre has a 20 to 1 chance of being due to difference in treatment and is considered to be statistically significant.

CONCLUSIONS.

On the area in question and under the conditions of the experiment :—

1. Ground limestone broadcast at the rate of 3, 6 and 9 tons per acre, gives in each instance markedly significant increases over the control ;

2. Six tons of limestone give an increase over 3 tons which is almost statistically significant, while 9 tons give a statistically significant increase over 6 tons.

3. There is no advantage to be gained by raising the dose to 12 tons as this gives the same yield as 9 tons.

4. There is no response to phosphate, and its application seems to have a tendency to depress the yield.

As the limestone is expected to make itself felt for several years, the experiment will be continued as 1st and 2nd ratoons, and it will probably be advisable to replant for another cycle. Until further data are available, no pronouncement can be made on the economic aspect of the various applications.

SUMMARY.

An experiment on plant canes of B. H. 10 (12), executed on a markedly acid heavy silt at the Sophia Sugar Experiment Station, Demerara, British Guiana, has demonstrated that statistically significant increases are obtained over the controls, and over each other, by doses of 3, 6 and 9 tons, respectively, of ground limestone broadcast before planting and incorporated into the soil during tillage. No further increase in yield was obtained by raising the dose of limestone to 12 tons per acre. No response was obtained from the addition of half a ton ground rock phosphate per acre. Indeed there was a tendency for this dressing to depress the yield.

ACKNOWLEDGMENTS.

The writers beg to thank their colleagues of the Sugar Experiment Station and the Chemical Division, Department of Agriculture, for their help and co-operation.

PADDY VARIETY TRIAL IN FIELD TEST PLOTS.

PLANTATION PORT MOURANT, BERBICE, 1930.

BY

H. MACLUSKIE, U. D. A., (Aberdeen),

Agricultural Superintendent, Berbice.

This article describes the work done and the results obtained in the Paddy Variety Trial conducted at Plantation Port Mourant, Berbice, in 1930.

VARIETIES.

The following varieties were used :—

Name.	*Origin.*
Demerara Creole	Demerara
Blue Stick	Essequibo, otherwise unknown.
No. 76	India
No. 79	"
Carolina	U.S.A.
Lady Wright	"
Mexican Edith	"
C 14-31	Burma
A 16-34	"
Blue Rose	U.S.A.
H 7	Ceylon
No. 75	India.

THE FIELD.

The experimental area was situated about 1½ miles from the public road alongside the estate railway and was in the first place thickly covered with Bizzi Bizzi (*Cyperus* spp.)

This was cutlassed and ploughed in, early in May, and allowed to rot. At the same time 12 seed beds were prepared in a corner of the area, each being 1 square rod.

SEED BEDS.

The seed was soaked on the 29th May and 5 lbs. of each variety sown on the 1st June, *i.e.*, seed rate 5 lbs. per square rod.

On the 3rd and 4th June very heavy downpours of rain were experienced which severely washed the seed beds, somewhat checking germination.

From observations made at intervals it was recorded that germination was excellent in all cases but somewhat slower with Demerara Creole, No. 76 and C 14-31. Growth and colour were well maintained throughtout the seedling stage.

Lay Out.

On the 30th June, the area having been meantime thoroughly worked up during the seedling stage, demarkation of plots was commenced.

Size of Plots.

The plot area adopted was 1/200th acre or 33 ft. by 6.6 ft. Intervals of 2 ft. were left between each plot to prevent overlapping and possible mixing at harvest.

Transplanting.

Transplanting was commenced on the 8th July and completed on the 11th. The seedlings were well grown but inclined to be rather crowded in the nurseries. On the 14th July—3 days after transplanting was completed—the experimental area was submerged through excessive rainfall and when the water receded, it was found necessary to supply or replant to a considerable extent.

The varieties most affected were the American ones:—Lady Wright, Mexican Edith, Carolina and Blue Rose.

Supplying was completed on the 26th July and the area quickly regained a more uniform appearance. At the same time all the spaces between the plots were planted up with Demerara Creole in order to crop the area completely and reduce border effect and as nearly as possible adhere to field conditions.

By the beginning of August weeding became necessary and was commenced.

Growth, Etc.

About the same time it became apparent that the poorest portion of the field was in replicates Nos. 1, 4, 7 and 5 where a very slight depression occurred.

The American varieties in this area were particularly affected whilst the others did not appear to suffer markedly.

Growth and tillering were excellent with all except the American varieties. Blue Rose was poorest in all respects and appeared to flower in successive instances while putting on a minimum of growth. The first flowers appeared on 18th July and no other variety flowering was recorded until the 20th August.

During the entire growing period, water supply was well maintained and it was not until maturity that difficulties arose.

Two Burma varieties C 14-31 and A 16-34 being later in maturing it was necessary to maintain a water supply on these until a later period. These varieties were therefore surrounded by meres and the water was released from the rest of the area on the 24th October.

HARVEST.

Reaping was commenced on all varieties excepting A 16-34 and C 14-31 on the 4th November and completed on the 8th. C 14-31 and A 16-34 were reaped on the 26th of the same month.

In harvesting the plots little or no grain was lost but it was noted that Blue Stick was inclined to shatter and each plot was beaten separately upon a tarpaulin and winnowed upon another.

MILLING QUALITIES.

It was decided, in addition, to carry out further tests as to the milling qualities of each of the varieties.

For this purpose it was maintained that a representative mill be employed and the paddy (having previously been parboiled and sun-dried according to custom) was put through an ordinary huller.

The milled rice recovered was weighed and the percentage of Rice to Paddy calculated as shown below :—

Demerara Creole ...	71%
Blue Stick ...	70%
76	66%
79	67%
Carolina	73%
Lady Wright	72%
Mexican Edith ...	70%
C 14-31	72%
A 16-34	68%
Blue Rose	67%
H 7	67%
75	69%

COMPARATIVE RESULTS.

For the purpose of ready comparison the following table may be of interest :—

VARIETY	Date of flowering	Date reaped	Age days	Yield % mean of all plots	Average yield per acre bags.
79	Sept. 18	Nov. 4	146	170	37.2
Blue Stick	,, ,,	,, ,,	146	143	31.4
Demerara Creole	,, ,,	,, ,,	146	136	30.0
H 7	,, ,,	,, ,,	146	129	28.2
76	,, ,,	,, ,,	146	127	27.9
75	,, ,,	,, ,,	146	121	26.4
A 16-34	Oct. 13	,, 26	173	117	25.6
C 14-31	,, ,,	,, ,,	173	111	24.3
Lady Wright	Aug. 20	,, 4	146	55	12.1
Mexican Edith	,, ,,	,, ,,	146	49	10.7
Carolina	,, 29	,, ,,	146	31	6.7
Blue Rose	July 18	,, ,,	146	28	6.2

Discussion of Results.

In executing an experiment of this nature it is impossible to eliminate entirely variations due to soil differences, weeds, drainage, loss of grain during harvesting, etc. Unless therefore, the difference between the mean yields of any two varieties is great enough to be almost entirely due to difference in variety (*e.g.*, chances of 20 to 1) it is not usual to draw definite conclusions therefrom.

The yields of paddy in bags per acre in the table are means of 12 plots of each variety. Statistical analysis of the results indicates that any difference in the mean yield greater than 4.2 bags paddy per acre has a 20 to 1 chance of being due to the yield qualities of the variety. Any such difference, *i.e.*, more than 4.2 bags paddy per acre, is considered to be statistically significant.

The highest significant yield was therefore obtained from No. 79 ; there is no statistical difference between Blue Stick, Demerara Creole, H 7, and 76.

During the heavy rains after transplanting it was in blocks 1, 4, and 7 that flooding was most prevalent, yet No. 79 gave the highest yields in blocks 1 and 4.

On the other hand all other variety yields fell considerably in those blocks.

It would appear therefore, that No. 79 yields best under general conditions, but is distinctly superior under flooded conditions.

In the milling test, however, No. 79 fell somewhat in that it only yielded 67% of milled rice.

Demerara Creole and Blue Stick yielded very similarly despite the fact that Blue Stick had the propensity for shattering whilst in the milling test there was little to choose between them, yielding 71% and 70% respectively. Both of these varieties stood the heavy weather very well.

Regarding No. 76, No. 75 and H 7 little difference is apparent. All are good yielders, much of the same age and good upstanding varieties. The Burma varieties A 16-34 and C 14-31 fell slightly in yield, were tall—growing up to 6 feet—stiff strawed but of a longer growing period.

Conclusions.

From the results the following conclusions are drawn :—

No. 79 is the highest yielder under the conditions existing at the time of the experiment, but as a miller, falls short of others. It does well, however, under flood conditions and normal conditions alike.

Demerara Creole and Blue Stick are good yielders with bright samples and good milling qualities but Blue Stick is inclined to shatter on reaching maturity.

H 7, 76 and 75 are fairly good yielders and compare favourably in other circumstances with the best yielders.

The American varieties were poor yielders and with the exception of Blue Rose gave excellent milling recovery, but do not survive heavy rains.

WEATHER.

The weather after transplanting was completed was distinctly severe and occasioned considerable supplying in certain varieties.

During the remainder the weather became drier towards harvest and very suitable to the crop.

The total rainfall for the period was as follows:—

June	10.91
July	16.86
August	6.06
September	0.60
October	0.35
November	nil
Total	34.72 inches

ACKNOWLEDGMENTS.

I wish to express my deep appreciation for the facilities of land, labour and other assistance so kindly rendered by the Manager and Staff of Plantation Port Mourant, to Mr. E. M. Morgan, Resident Agricultural Instructor, Corentyne, for assistance given in the field and to Mr. H. D. Huggins, Ag. Agricultural Superintendent, for the statistical examination of the results obtained.

TOBACCO CULTIVATION IN BRITISH GUIANA

BY

H. D. HUGGINS, D.I.C.T.A.,

Acting Agricultural Superintendent, West Demerara.

The values of the Colony's imports of tobacco for local consumption in 1930 were :—

Class 1	Tobacco containing 25-38% moisture	...	$36,013
„ 2	„ „ less than 25% moisture	...	88
„ 3	„ as cigars	...	3,190
„ 4	„ as cigarettes	...	60,370
„ 5	„ as other kinds	...	183,591

Tobacco under Class 2 is unmanufactured tobacco and was imported in much larger quantities when cigarettes were manufactured locally. Within recent years factories have been established for the purpose of turning out cigarettes for the local demand. These factories have now ceased to operate although in the neighbouring colonies of Trinidad and Barbados the demand for cigarettes is largely met by local manufacture. Nevertheless, if cigarettes were manufactured in the Colony it appears probable that most of the light tobacco which would be used in the industry would have to be imported since experiments with the 'light' varieties have not given encouraging results on the typical coastland soils.

If, however, more of the tobacco under Class 2 were imported for cigarette manufacture, it would feasibly reduce the amount of tobacco imported as manufactured cigarettes (the result being that the manufacturing costs would be put in circulation locally and not abroad); in addition, a demand would be created for a certain amount of 'heavy' tobacco for blending purposes ; this 'heavy' tobacco can be, and is, produced locally.

The types of tobacco necessary for high grade cigar production are exacting in their demands and the indications are that, at the present time, the local agriculturists would find it more profitable to concentrate on the production of other grade tobacco. In Class 5 are included manufactured pipe tobacco and manufactured cigarette tobacco, the latter being used extensively throughout the colony in the preparation of hand-rolled cigarettes.

included under Class 1 is the cheap, heavy, black tobacco, used almost entirely for plug and pipe purposes by those who cannot afford to be fastidious, and is known colloquially as 'Black Fat'. It is tobacco suitable for the manufacture of 'Black Fat' which the writer considers that the local farmer may be

encouraged primarily to produce for it is the varieties capable of producing this black tobacco that have thus far given the most encouraging results. The factor limiting more extensive local production is the absence of a demand in the colony for the 'raw' leaf as at present only a very limited quantity of these leaves can be disposed of—to be used in the production of a cheap type of cigar known as 'Toms'. The small amount of unmanufactured tobacco, which contains less than 25 per cent. moisture, imported locally, is used almost entirely in the preparation of 'Toms'.

The writer has examined superficially black tobacco collected from a representative number of retail shops throughout the Colony. This examination discloses that the variation in colour, moisture content, aroma and burning qualities of the product generally sold is as great as may be expected in so cheap an article. To satisfy this not too exacting demand with a locally made product ought not to prove insuperably difficult if private enterprise and expert and experienced manufacturing advice were forthcoming, and it appears probable that were a steady demand created for 'heavy' (*i.e.*, unmanufactured) leaves a local supply would be encouraged and in time produced.

In the course of the performance of extension duties of the Department of Agriculture, the writer has visited a number of peasant tobacco cultivations and, as a result, it seemed that a useful purpose might be served if an attempt were made to state the important cultural practices followed in the growing of tobacco under local conditions. This course seemed all the more desirable as the Journal, formerly published by the Department of Science and Agriculture, containing an article by Dash[1] on the subject of Tobacco cultivation in Trinidad is now out of print.

SOIL.

The quality of the product (from the point of the manufacturer) in tobacco cultivation is admittedly affected very profoundly by environmental factors, particularly soil conditions; it has been shown by experience that cigar tobacco is most successfully produced on sandy or clay loams of high fertility, cigarette tobacco on light sandy loams and dark pipe and plug tobacco on more clayey soils. Nevertheless, it is not intended to discuss this phase in detail since the local peasant cultivator does not normally have a wide range of soil types from which to select. The range is even further restricted for this crop as the farmer normally has his farm 'aback' and some distance from his dwelling; his homestead is almost always situated on the front lands on an area averaging between three-fourths of an acre and one acre and it seems probable that, locally, tobacco may only be cultivated with success as a 'front lands' or homestead crop. The regular attention demanded by tobacco, at certain periods of its growth, will not permit of the area under cultivation being too far removed from the home of the cultivator, more especially as children

[1] DASH, J. S. *Journ. of Board of Agri. of B.G.* Vol. XX. No. 2, 1927.

should supply suitable and economic labour for horn worm control work. It is for these reasons that it appears that tobacco may be profitably introduced into the local peasant agricultural system only as a homestead crop, because the area which a family may be able to crop efficiently under tobacco is estimated at not more than one-third to three-fourths of an acre.

The plots on the front lands consist almost invariably of heavy clays. Hence, for local peasant tobacco cultivation, the problem resolves itself largely into one of successfully growing tobacco on the clay soil type. Work at the Department's stations indicates that this soil type, if well forked, drained and with a sufficient water supply, will produce satisfactory crops of the heavy leaf tobaccos such as the Kentucky One Sucker, Yellow Mammoth, and Comstock Spanish varieties.

Seed Supply.

It is advisable for farmers to secure seed, until more experience with the crop is obtained, from the local Department of Agriculture. A moderately large number of varieties is cultivated at the Department's Experiment Stations and only seed of varieties which have been found to give good yields under local conditions is distributed for planting; this is distributed free of charge. The practice of importing the seeds merely on the grounds of a catalogue description or of purchasing seed of untried varieties is not to be recommended since the behaviour of varieties so obtained must always be a matter for speculation until at least one crop has been grown.

Nursery Practice.

In the writer's experience the best results are to be generally obtained (under local conditions) if seed is first set in nursery boxes and then later pricked off into a seedling bed. Usually the seeds are sown in the rainy season and at such periods torrential downpours are frequent; the scant protection, usually by means of coconut branches supported on fork sticks, given to seed beds, often proves inadequate; in such cases the seedlings can be severely damaged by the mechanical action of heavy rain. Further, as the first five weeks of the seedlings' growth are spent in the nursery, and, as this frequently coincides with a period of heavy rainfall, it is seldom that the farmer can provide as good drainage in a seed bed as that which can be arranged in seed boxes. The seedlings, when big enough to be pricked off, are more able to withstand unfavourable conditions, and can be more evenly spaced in the seedling bed—thereby decreasing the chances of attack from 'Damping Off.'

Tobacco seeds are diminutive—Dash (*loc. cit.*) estimates that a level teaspoon contains 25,000 seeds—and can be sown evenly only if much caution be exercised. It has now become a regular nursery practice to place a small amount of seed in a

PLATE IV.

Photo by *C L C Bourn.*

A PLOT OF "HEAVY-LEAF" TOBACCO AT THE DEPARTMENT'S EXPERIMENT STATION

Note that flower stalks have been removed ("topped") in most cases; bagged heads, for seed supply purposes, are seen in the back-ground.

comparatively large quantity of some material such as finely sifted wood ashes, to stir thoroughly until the seed is well distributed throughout the ashes, and then to spread the whole evenly in the nursery box.

Good results can be obtained by sowing not more than one quarter of a teaspoon of good viable seed, well stirred with about a cigarette tin of sifted wood ashes, in two average sized nursery boxes (about 2 ft. x 3 ft. each). This would appear to be a large amount of seed but experience has shown that frequently many of the seeds do not germinate, a number of seedlings show signs of poor growth and only the most vigorous plants can be selected for field cultivation.

If sowing in a seed bed is practised even thinner nursery spacing should justifiably be adopted (*e.g.*, one teaspoon of seed to a bed 4 ft. wide and 24 ft. long). Seedlings are usually pricked off from the seed boxes about 5-5½ weeks after germination and transplanted from the nursery beds to the field about 18-20 days after ; if seed is sown in seed beds transplanting is done about 8 weeks after sowing—pricking off being generally omitted.

TRANSPLANTING.

Soil in which the crop is to be grown should be well prepared some time prior to transplanting. After the area has been weeded the soil should be flat forked—the clods of earth completely turned over and the roots of weeds exposed to the sun. In 2-3 weeks the upturned soil should give marked signs of the effect of weathering and should perceptibly be in a more 'crumbling' condition. When the soil is in this latter state pen manure can most conveniently and suitably be added to and incorporated with the soil during the final preparation before transplanting. It is recommended that pen manure at the rate of about 10-15 tons to the acre should be used. In those cases, however, where the supply of pen manure is very limited (and this applies almost throughout the colony) it is best to make holes about 6 inches in diameter, 9 inches deep and 3 feet by 2½ feet apart and to fill all the holes with a mixture of top soil and pen manure. In these holes the seedlings should be planted at approximately the same depth as that at which they were growing in the seed bed. The tap root of each seedling should be placed in the hole in the same position in which the root grew in the nursery and the root, if too long, must be cut before planting.

The seedling beds should be thoroughly watered a couple of hours before transplanting in order to facilitate the removal of seedlings, and every effort made to protect the rootlets as much as possible in the latter process. A thin pointed wooden peg has been found to be very useful in the lifting operations. In those cases when the seedlings have been pricked off from boxes into nursery-beds, the seedlings, planted in rows, can then be easily removed with a small hand fork, care being taken that the roots of each plant-let are surrounded with a small ball of soil.

The stage at which the transplants are removed is important as it has been found by experience that if seedlings are transplanted too early they demand a great deal of attention while if transplanted late the shock of transplanting seems to check their growth unduly. It is found that good results are to be obtained with transplanting seedlings whose largest leaves are about 4 inches long. Thus it is recommended that tobacco seedlings must be well established before they are finally planted into the field.

It is essential that the plants be exposed to the sun as little as possible in the interval before transplanting which should always be done late in the afternoon; the seedlings are thus in their new situation for some hours before having to withstand the effect of a day's sun and should be watered in the afternoon when they are transplanted and again on the following morning; the transplants should not be too freely or too frequently watered as this tends to encourage shallow, surface rooting. It is reported in Ceylon that the best results are obtained by watering, when necessary, at intervals of four days.

The distances apart of planting is a subject on which there is some difference of opinion. The writer[1] is in favour of a slightly wider spacing than is frequently advocated and considers that spacing distances, varying from $2\frac{1}{2}$ ft. x $2\frac{1}{2}$ ft. to 3 ft. x 3 ft., are likely to give the best results under local conditions with the varieties under discussion. A significant disadvantage with wide spacing is that a longer time must elapse before the soil is covered and weeds kept down, but these varieties are vigorous growers and it is found that with closer spacing a considerable amount of damage is done to the leaves in the latter stages of the crop when labourers are compelled to pass regularly between the plants in search of caterpillars.

Two surface cultivations, after the plants have been established in the field, preferably with hoes, both for the purpose of keeping down weeds and in order to produce a soil mulch, in most cases prove sufficient; cultivation should not be continued when the plants have made such growth that the leaves are prone to injury from the movement of the labourers and implements.

Suckering and Topping.

When flower heads begin to appear the terminal growing point should be broken off in order to prevent the development of flowers, fruits and seeds. The main object of this operation is to compel the plant to utilize the plant food, which would under natural conditions be used for the formation of reproductive organs, for the production of leaf material. Topping, if done judiciously, helps to ensure that large well developed leaves are formed which will be approximately at a uniform stage of ripeness when reaped. In the experimental plots topping was commenced about 3 months after germination. In those cases in which the plants appear to lack vigour and the leaves give indication of being under-developed, topping is done at an earlier stage than would be done in more luxuriantly growing plants.

[1] HUGGINS, H. D., *Agri. Jour. of B.G.*, Vol. II No. I., p. 183.

After the plants have been topped shoots make their appearance and develop rapidly in the axil of the leaves. These shoots should be broken off regularly at an early stage when they can be removed easily even with gentle pressure by the forefinger and thumb.

UNTOPPED PLANTS FOR SEED.

It has been explained that the flowering shoots should be removed from the plants of the general crop. A small number of vigorously growing and uniformly maturing plants which are true to type should be left untopped in order to supply seed for future planting. In those cases in which more than one variety is cultivated, or where 'wild' tobacco is growing in the locality, the flower heads of the selected plants should be bagged. Large grocery paper bags serve the purpose satisfactorily and should be tied in position before the flowers open. At intervals the bag should be untied, fallen flowers removed, a search for insects made and the bag retied at a higher point on the stalk in order to make room for the growing inflorescence.

As soon as the capsules turn brown, the seed should be collected and allowed to stand in a dry cool place until all excess moisture has been removed. When the seeds have been thoroughly dried they are removed from the capsules and separated from the broken bits of pod by winnowing. Only seed from well developed capsules should be selected and then stored in a dry glass bottle.

REAPING.

At the Experiment Station, Georgetown, plants were found to be ready for harvesting about 5 months after germinating and 3 months after transplanting.

The most easily recognisable sign of ripeness is the appearance of yellow spots on, and a general lightening of the dark green shade of, the leaves. As the leaves at the base of the plant are oldest the yellowing appears on these leaves first and at the time of reaping is more pronounced than on the upper leaves. The leaves, should, however, be reaped before they become markedly yellow as better results are obtained, when air curing is practised, if the leaves are not over-ripe. Another sign of ripeness is that the veins in the leaf become brittle and, if bent in the fingers, break easily.

It is frequently found necessary to reap, singly, the largest and ripest leaves at the base of some of the plants before the crop has uniformly matured but for the bulk of the crop good results are obtained, with the varieties under discussion. if the whole-plant method of harvesting is adopted. This method permits the crop to be reaped more quickly than if the leaves are cut individually.

The only system of reaping with which the writer has had experience (and which, it may be mentioned, has given satisfactory results) is that in which the stem is split with a sharp substantially made knife vertically from the top to within about 4-6 inches of the surface of the soil; a firm, steady pressure must be

maintained on the handle of the knife, which is manoeuvred so that the leaves are not injured in the downward course of the knife. The stem is then cut across (*i.e.*, horizontally) with a cutlass at ground level and the plant left lying in the field for a short time to wilt. Wilting facilitates the handling of the leaves which become more pliable and show less tendency to break ; the cut plants must not, however, be left too long in the sun or the leaves become sun-burnt.

Reaping should always be done on bright sunny days and should not be done early in the morning, when the leaves are still moist with dew, or immediately after rain ; reaping should preferably be done about 3 o'clock in the afternoon.

Care of Leaves In The Barn.

The harvested plants are hung on wooden laths, or more cheaply on wire suspended across the barn ; care should be taken that the plants are not packed too closely in the shed and a space of about 4-5 inches left between each plant. The barn should be constructed so that air can pass through freely and so that the leaves may be protected from excessive moisture even at such times when the weather is showery.

Especially at first, the harvested tobacco should not be allowed to dry out too rapidly, and if necssary should be protected from strong, drying winds. Local experience has shown that the damage from mildew and the depredations of caterpillars, which may be taken into the barn, are the factors needing most vigilant observation in the curing shed. Mildew was found to be most effectively checked by promptly removing all affected leaves (and when necessary plants) from the curing shed and also by keeping the percentage of moisture in the atmosphere in the barn as low as possible.

Caterpillars may be taken, as such or as eggs, with the plants into the shed at the time of reaping, and should be carefully and regularly searched for in the early days of curing ; the damage caused to tobacco, which is being cured, from this pest can be considerable.

The plants are usually 'cured' in the barn for about 40 days and then the treatment, for which the cultivator is responsible with this type of tobacco, may be regarded as being completed. A day on which the atmosphere is moist should be selected for the handling of the cured leaves as under such conditions the leaves are more pliable and less likely to be broken. The leaves, even the veins and mid-ribs of which should be thoroughly dried, are then stripped from the stem and sorted and put into the grades which the market may require.

Yield.

The progress reports on the tobacco trials carried out at the Experiment Stations, Georgetown and Cecilia, show that yields (calculated on an acreage basis) of 1400-1900 lbs. of cured leaf for the heavy types have been obtained under experimental conditions. It is therefore thought that a yield of 1,000 lbs.

of cured leaf per acre may be considered a conservative estimate and should be obtained under normal conditions by the local cultivator.

An average ratoon crop of about 400–500 lbs. of cured leaf per acre can also be expected ; it is observed that the leaves from this crop are smaller and usually fetch a lower price than do the leaves of the first crop but nevertheless the ratoon crop gives to the cultivator a fairly high margin of profit. It is also observed that there appears to be a tendency for Mosaic Disease to appear more generally in the ratoon crop.

PESTS AND DISEASES.

The most serious damage to the crop locally has been caused by the 'horn worm.' After the crop has been established in the field the control of these caterpillars has been found, in the Department's trials, to be responsible for most of the attention demanded by the crop during the growing period. The caterpillars were hand picked *regularly* at mornings and/or at afternoons as a very high percentage of the leaves was damaged in the course of a few days if the control of the pest was neglected. The presence of one or more caterpillars on a plant can be detected by the absence of leaf tissue which appears to have been recently eaten and by the appearance of the small black droppings of the insect on the leaves or on the surface of the soil in close proximity to the plant. In the event of trouble from this pest farmers are advised to consult the Department of Agriculture.

Children can easily be trained to hand-collect this pest and at the same time may be taught to perform all the suckering operations necessary. If the children are intelligent enough even topping may be done by them. By these means labour costs may be considerably reduced.

The tobacco bud-worm also does some damage and the control used has been the hand collecting of the caterpillars.

'Damping off' has frequently been responsible for the death of a large number of seedlings in the nursery. Care should be taken that seed is not sown too thickly and that the nursery boxes be not kept too moist.

Mosaic Disease (recognisable by its characteristic light and dark green shading on the leaves) has been discovered on certain plants at the Experiment Stations. The chief methods of control are selection of seed from non-infected parents and the removal and burning of infected plants. Precaution should be taken that labourers carrying out the latter operations should not afterwards be allowed to handle healthy plants until their hands have been thoroughly disinfected.

THE EGG-PLANT STEM-BORER, ALCIDION DELETUM BATES. (COL. CERAMBYCIDAE.)

BY

L. D. Cleare, Jr., F.L.S., F.E.S.

Entomologist, Department of Agriculture, British Guiana.

INTRODUCTION.

The fruit of the egg-plant (*Solanum melanogena*) or "boulanger" as it is known locally, is a vegetable much used by the East Indians of British Guiana, and is used also by other sections of the community. For this reason it is one of the vegetables most cultivated in the Colony, and as cultivation goes here it receives a fair amount of attention, probably as much as any other garden crop ; it is usually well manured with farm-yard manure in its early growth, weeded at intervals, and regularly watered when necessary. Although planting may occur at any period of the year it invariably takes place at the commencement of the rainy seasons in May and November. The crop matures quickly, fruiting commencing in about twelve weeks. Often the plants are cut back shortly before fruiting is complete and a second and somewhat smaller fruiting is obtained in this way, though this depends on weather conditions.

Of the insects which attack this plant on the coastlands of British Guiana, the stem borer, *Alcidion deletum* Bates, is one of the more important, and the writer has observed attacks of this insect in several districts on the coastlands of the Colony. For this reason investigations to determine the life-history and habits of the insect were undertaken, and the results obtained are set out hereafter, together with suggestions for combating the insect.

NATURE AND EXTENT OF INJURY.

The injury caused by the egg-plant stem-borer is of two kinds and produced by different stages of the insect, namely, injury caused by adults and larval injury. In both forms the fruit of the plant is never attacked, the injury being confined to the stems. Of these the larval injury is the more important and will be dealt with first. Plants of all ages are attacked and stems of even half-an-inch or less in diameter may be bored, indeed the attack usually commences in the young stems and the larva continues its development as the stems increase in size and until they are an inch or more in diameter. Thus one never finds young larvæ in the mature and old parts of the plant although those that are full-grown or nearly so, as well as pupæ, are usually to be met with in those positions. Indeed one may find all stages

of the insect from egg to adult beetles in a single plant, the progression in growth of the insect corresponding with the age of the part of the plant attacked from top to bottom. The injury is in the nature of a tunnelling of the stems of the plants longitudinally, the larva feeding upon the pith which it will devour completely in the area in which it is situated.

The injury caused by the adult is produced in two ways, by the emergence of the insect from the stem after it has transformed, and also by the feeding of the beetle. Some days after it has transformed to an adult the insect leaves the stem by gnawing a circular hole through which it escapes. These holes apart from direct injury which may involve the splitting of the stem for some distance in their vicinity, serve also as a means of entry for organisms which may seriously affect the plant. The beetle feeds principally upon the young and tender shoots of the plant eating small areas of the bark. In this way at times considerable areas of the bark may be destroyed with its resultant ill effects on the plant.

It is difficult to say whether the attacks of this insect usually prove fatal to the plants, but attacks greatly affect the vitality of the plants, and frequently cause splitting and breaking of the stems, thus severely curtailing their productivity. In addition it appears to shorten the period of production, causing replanting to take place sooner than would be necessary but for these attacks.

LIFE HISTORY AND HABITS.

THE EGG.

The egg (Plate V. fig. 1.) is pearly white in colour, elongate in shape, one end being more pointed than the other, and one side slightly more convex than the other. The surface is smooth and shining. Length 1.7 mm. by 0.5 mm. broad.

OVIPOSITION.

The eggs are deposited singly, although at times two or even three may be found together, under the bark of the stem usually about the nodes, but occasionally also in the inter-nodes. At the place of oviposition the stem shows small holes slightly less than 1 mm. in diameter, and after a few days, a dark brown area of decay, especially in the younger stems and at the nodes. In a few instances it was observed that the egg was placed beneath the cambium-layer at the edge of the pith, oviposition in these instances apparently having taken place through a leaf scar and the pith thus easier reached. In captivity, oviposition took place between the late afternoon and early morning hours, possibly during both periods. On one occaion a female beetle was observed with her ovipositor inserted in the bark at 11 a.m. and an egg was subsequently found at this place, but it appeared that the female was unable to extricate her ovipositor, and it is possible that oviposition had occurred some hours previously.

Oviposition Period and Number of Eggs Laid.

The period time over which egg-laying may occur and the number of eggs laid by a female was obtained for eight females, and the results are given in Table I.

TABLE I.—*Number of eggs laid by the egg-plant stem-borer, and period of egg-laying at Georgetown, B.G.*

No. of eggs laid.	Period of egg-laying.
	Days.
20	14
33	26
20	26
11	7
22	20
78	40
19	6
23	17

From the data obtained it was found that as many as 7 ova may be deposited by a female during a period of 24 hours, and that the deposition of 3 ova in 24 hours by one female was not unusual.

The eggs were produced in the months of April, May, August, September, October and November.

Incubation

The period of incubation was observed in only a few instances and was found to vary from 3 to 7 days. Observations were made on the incubation period of 50 eggs, and the results are set out in Table II.

TABLE II.—*Incubation periods of 50 eggs of the egg-plant stem-borer at Georgetown, B.G.*

Number of eggs hatching.	Duration of egg period.
	Days
1	3
31	4
13	5
2	6
3	7

With a single exception which occurred in August, all the eggs that hatched in 4 days were laid in September towards the end of that month.

The Larva.

The full-grown larva (Pl. V. figs. 2 and 5) is a cream-coloured footless grub of the usual Cerambycid form. The head is somewhat darker, the cephalic one-fourth being brown, gradually becoming darker until the mandibles are almost black. At the junction of the head and the first thoracic segment there is a median V-shaped area of brown. The inter-segmental constrictions are pronounced, and the dorsal and ventral surfaces of the first ten segments are elevated and roughened, the eleventh segment showing only slight roughening both dorsally and ventrally. The body is sparsely covered with stiff brown hairs which are of greater length on the sides and on the 1st, 2nd, 10th, 11th, 12th and 13th segments. The larva has its greatest width at the 2nd segment, gradually becoming narrower to the 9th segment, then broadening slightly again to the 10th and 11th segments. The spiracles are brown and are situated on the 2nd and the 4th to 11th segments. The fully grown larva measures 16.0 mm. long and 3.0 mm. at its greatest width.

Habits of the Larva and Length of Larval Life.

The length of time spent by the insect in the larval stage may vary considerably. The duration of the larval life of 26 larvæ reared in the laboratory ranged from 36 to 77 days, and is shown in Table III.

Table III.—*Length of larval life of the egg-plant stem-borer at Georgetown, B.G.*

Period in Days	Number of Larvae	Period in Days	Number of Larvae	Period in Days	Number of Larvae	Period in Days	Number of Larvae
36	1	46	1	58	1	65	1
37	2	52	1	59	1	67	2
38	1	54	1	61	2	68	1
42	1	56	2	63	3	69	1
45	1	57	1	64	1	77	1

Owing to the habit of the beetles of depositing eggs in the young stems when the larvæ hatch from the eggs they are in tissue soft enough for them to feed upon, and with the gradual growth of the stem they are able to occupy the pith without having to bore through hard wood as would be necessary were the eggs deposited in old stems. When the larvæ become fully grown they destroy the entire pith in the areas of the stem they occupy, which may be a length of a stem of three or four inches.

The larvæ show distinct canabalistic tendencies, and if through excessive infestation or for some other reason two larvæ, a larva and a pupa, or even a larva and an adult come in contact in a stem through an insufficiency of space

one larva will attack and kill the other, especially if the other is in a pre-pupal stage and therefore more or less quiescent, while in the same way pupæ will be attacked, or even a newly formed adult that has not yet left the stem.

THE PUPA.

The pupa (Pl. V. figs. 3 and 7.) is a creamy white colour. The femur of each leg is folded obliquely backward on the ventral side of the body the tibia being placed transversely across the body at right angles to the median line, an acute angle being thus formed between the femur and the tibia (the angle is not so great in the first pair of legs), while the tarsi extend backward beside the median line. The wing-pads are also folded obliquely backward and downward, passing between the body and the first two pairs of legs, the tips extending under the posterior pair of legs. The antennæ curl outward and backward dorsally to the two posterior pairs of legs, then ventrally and inward past the third pair of legs, where they curl inward nearly to the median line then almost straight forward along the tarsi to the first pair of tibæ. On magnification a number of small brown hairs are noticeable on the femora, tibæ and front of the head. The pupa measures from about 11.0 to 14.0 mm. long by from 5.0 to 6.5 mm. broad.

PUPATION AND LENGTH OF PUPAL PEROD.

Pupation takes place within the stem of the plant in a cell prepared by the larva (Pl. V. fig. 7). This is done by blocking the stem both above and below itself with frass and fibrous strands of the stems, the pith having been previously eaten away. The posterior end of the cell is usually composed of a wad of finely divided material, tightly compacted, although it often contains some fibrous strands and may be even entirely fibrous, its composition being dependent on the material at the disposal of the larva and its proximity to other larvæ in the stem which factors also regulate the thickness of both the anterior and posterior layers. The anterior layer on the other hand, is always entirely composed of fibrous strands. The interior of the cell is smooth and ovoid in shape.

The pupal period as observed in 57 instances varied from six to eight days. The results are given in Table IV.

TABLE IV.—*Pupal period of the egg-plant stem-borer at Georgetown, B.G.*

Number of insects.	Pupal period.
	Days
8	6
32	7
17	8

THE ADULT.

The adult egg-plant stem-borer (Pl. V. fig. 4) is a small beetle, measuring from 8.2 to 12.1 mm. The general colour is a greyish brown with darker markings of a brown colour on the elytra.

HABITS OF THE ADULT.

After the emergence of the adult from the pupa the insect remains within the stem for from two to ten days. It then emerges by gnawing a circular hole in the stem about 5 mm. in diameter (Pl. V. fig. 6). Occasionally, in the laboratory, the adult failed to emerge from the stem in its first attempt but a second always proved successful, and such beetles remained within the stems for the maximum period given above. Observations were made on the period spent in stem prior to emergence in 55 insects and the records obtained are given in Table V.

TABLE V.—*Period spent in stem by adult beetles of egg-plant stem-borer.*

No. of insects.	Period in stem
	Days
1	2
1	3
6	4
8	5
10	6
21	7
7	8
0	9
1	10

Adult beetles of the egg-plant stem-borer have been obtained in the field in the months of April, May and June, and in the laboratory in March, April, June, September, October and December. It is probable, therefore, that adults are to be found throughout the year.

The longevity of 45 beetles used in the rearing trials was observed and varied from 3 to 161 days. The records are given in Table VI.

TABLE VI.—*Longevity of egg-plant stem-borer at Georgetown, B.G.*

No. of Insects	No. of Days	No. of Insects	No. of Days	No. of Insects	No. of Days	No. of Insects	No. of Days
2	3	3	12	2	19	1	39
2	5	2	13	1	24	1	44
2	6	3	14	2	25	1	48
4	7	1	15	2	26	1	58
1	9	1	16	1	28	1	65
3	10	1	17	1	31	2	90
1	11	1	18	1	33	1	161

In the laboratory the beetles fed to a considerable extent on both the young and tender as well as on the tough bark of the stems of the plants. In the laboratory they also fed readily on a solution of cane-sugar and water. Feeding took place either during the night, or, more probably, in the early morning and early evening hours and was never observed during the day time. Indeed all the activities of the beetles seem to occur during the hours of darkness; in the laboratory they remained quiet resting on the stems and branches during the day, adult beetles have never been observed in the field.

LIFE CYCLE AND NUMBER OF GENERATIONS.

The period of time required by the different stages of the life cycle of the beetle, from the deposition of the egg to the emergence of the adult beetle from the stem, as observed in the laboratory, are summarized in Table VII.

TABLE VII.—*Time required by each stage in life cycle of egg-plant stem-borer at Georgetown, B.G.*

Stage of Insect	Duration in Days.		
	Min.	Max.	Ave.
Egg ...	4	6	4.5
Larva ...	36	77	51.1
Pupa ...	6	8	7.1
Adult in stem	2	10	6.2
Total Life Cycle	48	101	68.9

In 22 individual insects in which the life cycle was observed, from the deposition of the egg to the emergence of the beetle from the stem, the total number of days required for the completion of the life cycle varied from 53 to 96. The results obtained are given in Table VIII.

TABLE VIII.—*Time occupied by egg-plant stem-borer in completing its life cycle at Georgetown, B.G.*

No. of Days	No. of Insects	No. of Days	No. of Insects	No. of Days	No. of Insects
53	1	75	3	83	1
56	1	76	1	85	1
63	1	78	1	86	2
64	1	79	3	87	1
72	1	80	1	96	1
74	1	81	1	...	...

From the foregoing data it would appear that three or four broods of the insect occur during a year, and that there is an over-lapping of generations somewhat after the manner shown in the diagram below (Fig. 1). Adult beetles have been obtained in nearly every month of the year and when considered with the longevity of the beetles would indicate also an over-lapping of the broods.

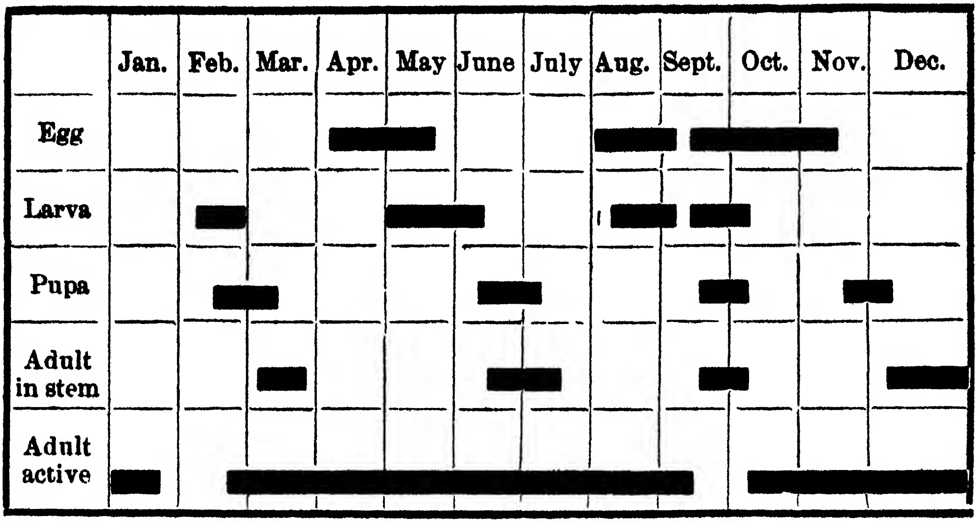

Fig. 1.—Diagram showing the time of occurrence of the stages of the egg-plant stem-borer.

NATURAL ENEMIES.

Only a single parasite of this insect has been reared during the investigations. This insect is the Braconid *Ipobracon waterstoni* Cam., a larva of which was found parasitizing a larva of the egg-plant stem-borer. This specimen was obtained at Cove and John, E.C. Demerara, during the month of September. In the same area adults of this parasite were observed in fair numbers in the month of February hovering about egg-plants which were infested by the stem-borer.

METHODS OF CONTROL.

Much could be done in the way of controlling the stem-borer by the discontinuance of the habit of cutting back the plants and running them over another season. Although this would necessitate a more frequent planting, it is believed that the greater yield of new plants over those of the older ones would repay the extra labour entailed. There can be no doubt that when the plants are cut back unless they are cut down close to the ground many beetles

are left in the old stumps and serve as a nucleus for infesting the young shoots when they develop, while infestation also takes place from the old stems left about the field.

In addition, before replanting again takes place after the first season, all old plants should be collected together and burnt. In this way the chances of infestation amongst the new plants would be considerably reduced.

As pointed out above, from the life-history of the insect there appears to be an over-lapping of generations, and for this reason no preference as to the time of planting is to be recommended from the point of view of controlling the pest. At present planting takes place at any time of the year provided there is water available for applying to the plants, but with our present knowledge there appears no necessity to change this.

EXPLANATION TO PLATE V.

THE EGG-PLANT STEM-BORER ALCIDION DELETUM BATES.

1. Egg × 20.
2. Larva × 2.
3. Pupa, aspect × 3.
4. Adult, female × 3.
5. Larva in burrow in stem of egg-plant × 2
6. Pupa in cell in stem of egg-plant × 2.
7. Exit holes of beetles in egg-plant stem. About natural size.

(Photographs by L. D. Cleare, Jnr)

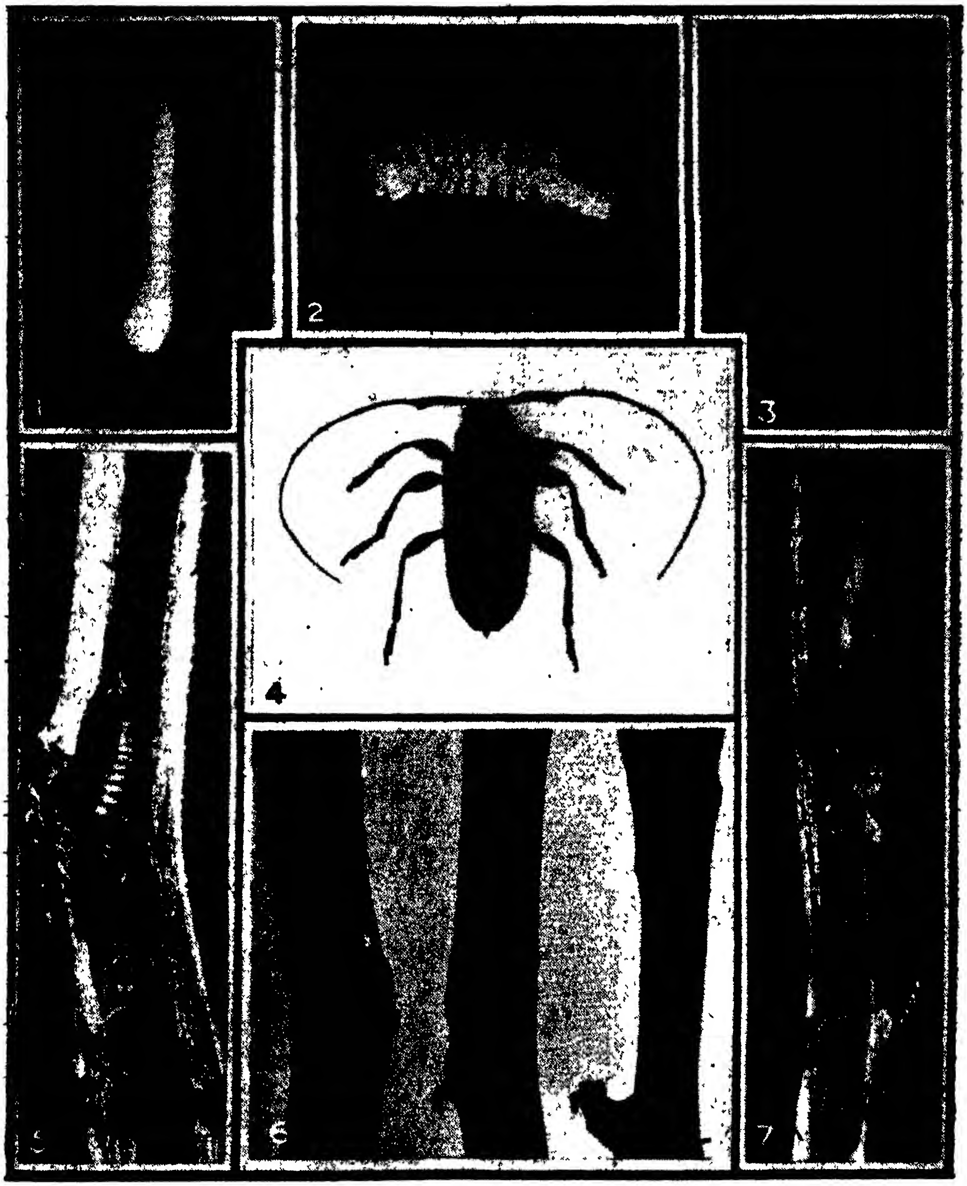

Photo by *L. D. Cleare, Jnr*

THE EGG-PLANT STEM-BORER, ALCIDION DELETUM BATES.

THE ESTIMATION

OF

READILY AVAILABLE PHOSPHORUS IN SOILS.

BY

C. L. C. BOURNE,

Assistant Chemist, Department of Agriculture, British Guiana.

In order to determine the phosphate requirements of cane lands in British Guiana, it has been customary in the past for chemists to estimate the amount of phosphoric anhydride soluble in 1 % citric acid solution after continuous shaking of the soil with this solvent for 5 hours, using a gravimetric or volumetric method for the estimation.

Truog [1] has devised a method of extraction with very dilute sulphuric acid (.00 2 N) buffered with ammonium sulphate to a pH of 3, followed by the Deniges colorimetric method for estimating the phosphate. This procedure is considerably quicker than the citric acid method and is claimed to have given satisfactory results.

For the purpose of comparison, the available phosphate in 28 soils of British Guiana has been determined by the two methods and the results appear in the table appended. The correlation coefficient is +0.898. This appears to be satisfactory, and the following method is recommended for trial to sugar estate chemists.

It should be noted that Harrison [2] working on cane soils of British Guiana found that those yielding 70 p.p.m. P_2O_5 (.007% P_2O_5) or more to 1% citric acid did not respond to manuring with phosphate and this figure has been generally adopted as a standard for British Guiana.

As a result of the examination of several types of soil by the Truog method of extraction it is tentatively suggested that soils yielding more than 18 p.p.m. of P_2O_5 by this method will not respond to phosphatic manures.

It should be stated in this connexion that a manurial trial recently carried out at Pln. Uitvlugt showed no response to dressings of phosphatic manures. The soil of the area yielded 40 p.p.m. P_2O_5 by the Truog method.

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(1) Journ. Amer. Soc. Agron. Vol. XXII No. 10, Pages 874-882.

(2) W. I. Bulletin Vol. XIII 1913, Page 176.

PROPOSED METHOD FOR DETERMINING READILY AVAILABLE PHOSPHORUS OF SOILS.

REAGENTS.

Ammonium molybdate-sulfuric acid solution.—Dissolve 25 grams of ammonium molybdate in 200 cc of water heated to 60° C and filter. Dilute 280 cc of arsenic-and phosphorus-free concentrated sulfuric acid (approximately 36 N) to 800 cc. After both solutions have cooled, add the ammonium molybdate solution slowly with shaking, to the sulfuric acid solution. After the combined solution has cooled to room temperature, dilute with water to exactly 1,000 c.c. This is a 10 N sulfuric acid solution containing 2.5 grams of ammonium molybdate per 100 c.c.

Stannous Chloride solution.—Dissolve 25 grams of $SnCl_2 . 2H_2O$ in 1,000 c.c. of dilute (10% by volume) hydrochloric acid solution. Filter if necessary. Store in a bottle with a siphon or side opening near the bottom, arranged with a glass stopcock for delivering the solution in drops, The solution should be protected from the air by floating a layer of white mineral oil about 5 mm. thick over the surface.

Sulfuric acid solution for extraction.—Prepare a stock solution of exactly N/10 sulfuric acid by titrating against standard alkali. Dilute convenient volumes of this to 0.002 N and buffer by adding 3 grams of ammonium sulphate per litre so as to produce a pH of 3 in the final solution.

Standard phosphate solution.—Dissolve 0.1917 gram of recrystallized potassium dihydrogen phosphate and dilute to 1,000 c.c. This solution contains 100 p.p.m. of P_2O_5 and is too concentrated to use directly. A second stock solution is made by taking 50 c.c. of the first stock solution and diluting to 500 c.c. This second stock solution (which does not keep well and should be made up weekly) contains 10 p.p.m. and is used for making the standard solution for comparison. To make this standard solution take 5 c.c. of the stock solution, dilute to 95 c.c. with distilled water, add 4 c.c. of the ammonium molybdate-sulfuric acid solution, and mix thoroughly by shaking in an Erlenmeyer flask, Add 6 drops of stannous chloride and shake. Dilute to exactly 100 c.c. shake, and the solution is ready for use. It contains 0.5 p.p.m. of P_2O_5. After standing for ten to twelve minutes, the standard starts to fade and a drop more of the stannous chloride solution should then be added to bring back the full colour.

EXTRACTION AND DETERMINATION OF THE READILY AVAILABLE PHOSPHORUS.

Extraction and determination.—Place 2 grams of 20-mesh soil and 400 c.c. of the 0.002 N sulfuric acid in a 750 c.c. Erlenmeyer flask or other suitable container and shake for one half hour. Filter through S.S. 589 filter paper. Discard

filtrate until it comes through *perfectly* clear. Then place 50 c.c. of the clear filtrate in a 200 c.c. Erlenmeyer flask, add 2 c.c. of the ammonium molybdate-sulfuric acid solution, and shake well. Then add 5 drops of the stannous chloride solution, shake, and compare with the standard within a few minutes. In making the colour comparison with ordinary Nessler tubes it is convenient to proceed as follows :—Place the 52 c.c. of unknown in a Nessler tube and the standard in a 100 cc cylinder. Hold the tube with the unknown together with an empty Nessler tube over a white back-ground and pour standard solution from the cylinder into the empty tube until the colours match. Then read the cylinder to ascertain the amount of standard required.

Calculation.—When the comparisons are made as just indicated, the calculation is very simple. The 52 c.c. of unknown solution represents 0.25 gram of soil. If the standard contains 0.50 p.p.m. of P_2O_5, and if it took, say, 40 c.c. of standard to match the unknown, the amount of readily available phosphate in the soil will be equal to $\frac{40}{0\,25} \times \frac{0\,50}{1}$ or 80 p.p.m.

Important precautions.—It should be noted that arsenates produce exactly the same colour as phosphates, and that reagents, filter paper, and glass often contain appreciable quantities of arsenic. Pyrex glass contains 0.7% arsenic oxide and the use of new pyrex vessels will cause serious contamination. All glassware should be thoroughly weathered by treatments with warm sulphuric acid-dichromate solution for at least 24 hours. Filter paper may be tested by tearing up a sheet of it and throwing the shreds into a blank test. If a colour develops on shaking, the filter paper is, of course, not suitable. It is absolutely essential to run a blank on all chemicals and glassware at frequent intervals. To test the chemicals proceed as follows :—Add 4 c.c. of the ammonium molybdate-sulphuric acid solution to 96 c.c. of water and after mixing thoroughly add, with shaking, 6 drops of the stannous chloride solution. Compare in Nessler tubes with pure water. If the chemicals are free of arsenic and phosphorus not more than a very faint blue colour is produced.

It is important that the proportion of solvent to soil should be kept constant and that 2 grams of soil be taken.

	Citric Extract Gravimetric Method p.p.m. P_2O_5	H_2SO_4 Extract Colorimetric Method p.p. m. P_2O_5
D 293	50	8
D 294	47	14
D 298	71	8
D 302	411	100
D 303	241	50
D 304	1027	160

D 305	74	30
D 254	407	40
D 342	240	20
D 344	143	20
D 346	115	8
D 348	79	10
D 350	104	10
D 352	199	22
D 354	167	22
D 356	129	30
D 284	71	6
D 285	45	12
D 287	23	14
D 240	319	20
NW 110	12	16
NW 111	11	12
NW 112	10	8
ECP VIII	50	40
ECP IX	124	30
ECP X	127	20
ECP XI	21	16
ECP XII	25	16

PLANT DISEASES.

NOTES ON SOME DISEASES OF LOCAL ECONOMIC PLANTS AND THEIR RELATION TO ENVIRONMENT.

BY

E. B. MARTYN, B.A., (OXON.),

Botanist & Mycologist, Department of Agriculture.

In respect of Plant Diseases, as distinct from Insect Pests, this Colony is fortunate in being on the whole free from any serious complaints. When the loss caused to cane growers by Mosaic, gumming, etc., in other countries is considered, local planters must congratulate themselves on the complete absence, so far, of these major troubles. Rice as a crop is not usually liable to any devastating disease, and the losses from disease in the colony are entirely negligible. Our two principal crops therefore, may be regarded as being very healthy. In order that they should remain so, it is of the utmost importance that the introduction of any of the serious diseases from other countries, especially those of cane, be avoided.

Some of the lesser crops, however, are not so fortunate, and Wilting of Coconuts, also of Plantains and Bananas, are common enough in many places. Should Cocoa ever assume again a position of importance, the Witch Broom Disease would prove a serious enemy to it in most districts, and a difficult one to eradicate. Coffee in the North West is liable to the Sclerotium Disease, though this does not normally take a heavy toll of the crop. The fruit trees of the colony on the other hand are, for the most part, healthy. The majority of the vegetables grown locally are seldom affected by disease, but when the cultivation is attempted of those with somewhat exacting requirements, such as the tomato, the grower may find himself faced with losses.

This brings us to the consideration of the relationship of the plant and its environment to its state of health. Certain diseases, caused by organisms which are virulent parasites, attack plants which are in vigorous condition. Many diseases, however, are brought about by fungi and bacteria which can only attack tissues already weakened, or gain entrance by means of wounds. Often no fungus appears until the plant tissues are actually dead. Most of the plant diseases of this colony at present are of this "secondary" nature.

Many cultivators, when disease appears among their crops, overlook the real cause of the trouble, and think that it is immediately desirable to apply some rem-

edy in the nature of a spray. The analogy to human disease, and the supposed beneficial effect of taking "medicine" in any form, is obvious. Just as the human patient is more prone to illness when weak, and better able to recover if his strength is renewed, so the plant under adverse conditions is an easy victim of "secondary" diseases, and better fitted to resist them if it be invigorated. In the case of plants, as with man, "prevention is better than cure," since often when disease symptoms first become apparent, the trouble is already too far advanced to be stayed. Furthermore, it must be remembered that the spraying of plants, as a method of preventing or eradicating disease, is an expensive operation if it is to be done on a large scale. In the case of permanent crops, covering a large area, the value of the crop and the increase in yield to be expected may justify the expense incurred. For the small farmer, however, it is seldom remunerative.

The first consideration in maintaining plants in a healthy condition is careful attention to the ordinary practices of agriculture. The greater part of the cultivated areas of the colony are on low-lying lands, proper drainage therefore is of primary importance. "Wet feet" is the cause of debility and diseases in many cases, and poor drainage means further a lack of movement of the water in the soil, and a consequent tendency for harmful constituents to become concentrated. Again, the heavy clay soil so commonly found on the coastlands calls for constant tillage, and intermixture with pen manure or green crops, if it is to be kept in any sort of condition to encourage root development. Mulching too is necessary during dry weather to retain the moisture.

Finally, it is essential to avoid overcrowding of plants, especially crops of a permanent nature, as fruit trees, coconuts, etc. Many such plants are grown in situations not well suited to them, and under such conditions can only be expected to yield adequately with a maximum, and not a minimum spacing. It should be remembered too that all weeds allowed to develop are competing with the crop for the available plant food, and should therefore be kept constantly under control. These points are obvious enough, but it is surprising how often one or more of them are overlooked.

The above are, however, only the usual methods of cultivation, to enable plants more or less suited to their surroundings to develop to the best advantage, and maintain a healthy condition. When plants are introduced to an environment entirely strange to them, and are cultivated under conditions to which they are not well suited, it must be realised that they need all the more assistance to ameliorate their surroundings, and further steps may be necessary to enable them to thrive. These include such operations as additional drainage, deeper tillage, fertilisation of the soil, growth of cover crops, introduction of artificial shade, or special preparation of beds. If it is not possible to carry out these operations where necessary, it is better not to attempt the cultivation of the crop.

PLATE VI.

Photo by H. D Huggins

FIG. I.

Photo by H. D. Huggins

FIG. II.

TYPICAL CASES OF 'PLANTAIN DISEASE.'

The fruit on the plant on the right is shrivelled and useless.

Instances may now be taken of some of the diseases of local crops and the steps that may be taken to combat them by attention to proper methods of cultivation.

COCONUTS.

On some of the larger sand reefs of the coastal belt, excellent coconut plantations can be seen, but on the other hand, it is only too common a sight to see coconuts on the coastlands that are stunted and poorly developed, and many may be observed that are dying, or already dead, from Wilt Disease. The coconut grows naturally on a light, well drained soil, typically the seashore. It is a common practice locally to plant it on worn cane lands, even on lands that will never grow cane, or on narrow sand reefs with an immediate clay subsoil.

What drains were present when the plants were put in are often allowed to become choked, and a heavy growth of weeds competes with the plants. Under the very conditions when the plant needs every assistance to encourage its growth in an alien habitat, it is left to fight for itself. It is not to be wondered that, after bearing for a few years, the struggle to obtain the necessary subsistence from the soil becomes too much, that the roots which are endeavouring to develop in a soil, sticky in wet weather and hard as concrete in dry weather, cannot function properly, and that the plant wilts and dies.

It is not advisable to plant coconuts at all on the heavy clays, but if they are to have any chance of success it is essential that they be well spaced, that the ground be kept properly drained and clean of weeds, and that the soil be cultivated, and if need be, manured. That the coconut can be left to look after itself in conditions utterly foreign to its nature is a fallacy. With care, however, it can be a valuable crop.

PLANTAINS AND BANANAS.

These suffer from a wilt disease which can be ascribed to definite organisms. Bacteria are found commonly associated with the suckers of diseased plants, and *Fusarium cubense*, the Panama disease fungus, has also been found associated in some cases of wilt. It would appear, however, to be a less virulent strain of the fungus than that which has caused such widespread damage elsewhere.

Where the wilt disease has taken a hold, it is useless to attempt the further cultivation of Plantains for a while, and such areas should be given over to the growth of other provision crops, care being taken that no diseased suckers are used for planting elsewhere.

Though wilted plantains have doubtless been killed by the organisms concerned, it is often noticeable that if suckers be dug up in the near neighbourhood of a wilted plant, or outlying undiseased suckers be taken from an affected stool, the roots of these are brown and discoloured. This discoloration, quite distinct from the red colour of the diseased tissues, indicates that the roots are unhealthy,

and are developing under inimical conditions, where they will be an easy prey to any invading organism.

Shallow pegasse soils with clay at a depth of a few inches do not appear as a rule suited to cultivation of Plantains, or the Cayenne Banana, and on such soils disease is usually most apparent. Suckers taken up are often found to show a very poor root development, most of the roots being dead and dried up. The leaves of the plants often show a tendency to wither, even when the suckers on examination show no typical signs of the disease. In dry weather especially the surface layer of pegasse becomes crumbly and hot, and affords little encouragement to root development. Also it is soon exhausted of plant food. On the other hand, the roots do not penetrate far into the underlying clay, especially when drainage is poor.

Recent research on Panama Disease indicates that healthy plants are attacked with difficulty by the fungus, but that roots growing in an unsuitable environment, and therefore weakened, readily succumb to it. It should be borne in mind too, that in diseases of this nature, conditions that are likely to lower the health of the plant are often the more beneficial to the attacking organism, which thrives under them and increases in quantity.

In Plantain cultivation also then the necessity of keeping the plant in a state of vigorous growth is obvious. Drainage and tillage are again of first importance. Greater attention too should be paid to the pruning of suckers. More often than not, nearly every sucker that comes up around the parent is allowed to develop, resulting in a large clump of plants in all stages of development, which hinder one another's growth, rapidly exhaust the soil, and allow of the Wilt Disease taking a strong hold should it make its appearance. For the Wilt Disease at present there is no cure, prevention if possible is therefore essential.

COFFEE AND COCOA.

Liberian Coffee in parts of the North West District is attacked by the Sclerotium Disease. One method of controlling the disease is by spraying, but this is likely to prove much too costly for the average farmer. By proper spacing and pruning of the trees, however, the humidity which favours the fungus is lessened. By removal and destruction of infected debris the source of new infection is greatly reduced. Thus this disease can be largely kept in check by very simple methods.

Cocoa in most areas where it is grown in the colony, with the apparent exception of the North West District, is affected by Witch Broom. Owing to the small interest taken now in the crop, this disease has been allowed to become rampant, and its eradication would be a difficult matter, calling for an organised campaign in the different areas concerned. Removal of fruiting bodies of the fungus, and infected shoots, together with their destruction, is a first essential.

PLATE VII.

Photo by H D Huggins

FIG. III.—A COCONUT FIELD BADLY AFFECTED BY WILT.
Note the prevalence of 'bush' amongst the palms.

Photo by H D. Huggins

FIG. IV.—A WILTED COCONUT PALM.
Note the heavy growth of weeds.

This step though, must be carried out by all concerned, as one area remaining infected forms a source of new infection for the whole neighbourhood.

Recent work in Trinidad has shown the importance of keeping trees properly pruned and in good condition, and of avoiding excessive humidity as far as possible, by attention to drainage and suitable reduction of shade. Under such conditions the disease can obtain but little hold on the trees, and is more easily eradicated.

FRUIT TREES.

The fruit trees of the colony are seldom seen to be attacked by disease, and it is to be hoped that citrus locally will continue to stay free of the very serious diseases which affect it elsewhere. Only one of these may be mentioned now, as its presence has been reported in the colony, though not recently. The disease referred to is 'Wither Tip,' or 'Blossom Blight' of Limes. This also attacks, in particular, trees weakened from one cause or another, or growing under conditions of extreme humidity. Its control by spraying is an expensive operation; its prevention if possible should rather be aimed at. Trees budded on the hardy sour orange stock are better fitted to resist this and other diseases, and spacing and pruning deserve the fullest attention.

The question of spacing of trees is all important. Too often the owner of a few square rods will try to crowd on to them a number of fruit trees of all kinds, which, when mature, compete with each other for the available food in the soil, to their mutual disadvantage, and hamper each other in their demands for light and air. A few good trees are of far more value than a number of poorly developed specimens, and at the time of planting the size of the trees when mature, and their demands on the space available, should always be borne in mind.

TOMATOES.

Special mention may be made of this crop, since it is one popular with local cultivators, and liable to two very troublesome diseases, namely 'Wilt' and 'Blossom End Rot'. The former is caused by a fungus, *Fusarium lycopersici*. The plants wither and die, and on cutting open the root, the central tissues are seen to be blackened and discoloured. It is a source of trouble in most countries in which Tomatoes are grown. Successful results have been obtained in some places by the use of certain varieties which are resistant to the disease, but unfortunately a variety resistant under the conditions prevailing in one locality, may fail in another. The fungus is favoured by heavy and poorly drained soils, so that every attention should be paid to drainage, and to keeping the soil in the beds in as friable a condition as possible. Should any beds become badly affected by the disease, these should be used for planting different crops for the next few seasons. Under Greenhouse conditions sterilisation of the soil is sometimes practised, but in the field, this is a difficult matter.

'Blossom End Rot' is a very common complaint locally, and is likewise of world-wide occurrence. The exact cause of the disease, though it has been made the subject of much research, is still somewhat uncertain. It is considered, however, to be closely associated with the water supply of the plant. The disease affects ripening fruits, at the 'blossom end' of which a small brown patch appears, this may extend and form a starting point for the attacks of insects and fungi. On cutting open, the top half of the fruit is found to be soft and rotted.

To prevent the disease, every effort should be made to make the water supply to the plants as regular as possible. Excessive watering is to be avoided. In dry weather the soil should be mulched, and if the plants appear to be suffering from the sun at midday, light shade should be provided, by use of muslin, or palm leaves.

It will be seen therefore that the crops of the colony as at present cultivated do not suffer greatly from infectious disease, but are affected often by 'secondary' diseases, dependent in the first instances upon the weakening of the plant by some other cause. In this respect it is to be noted that a number of minor diseases, not present at other times, usually appear towards the end of the wet season—when humidity is high, and pass off with the beginning of the dry weather. Complaints of this nature observed during last wet season included 'damping off' of citrus seedlings, which withered and died: the appearance of a leaf spot on rose leaves in certain gardens; a spotting of soya bean pods; a leaf mould disease of tomatoes, etc. All of these were directly attributable to the extreme wet weather prevailing and passed off when the rains ceased. Their appearance on a small scale, though troublesome to the farmer, is usually unavoidable and presents no cause for alarm. Plants are similarly weakened in periods of drought, and it is noticeable that bad outbreaks of Coconut Wilt usually start at such a time.

Finally, it is to be noted that the principal crops of the colony today have for the most part been grown locally from time past, and have shown themselves to be free of any serious infectious disease. If and when the introduction of any new crop is contemplated, its liability to be attacked by disease must always be borne in mind. Notable examples in the past were the effect of American Leaf Disease on Rubber when cultivated in the colony, and also the frustration of an attempt to grow Sisal by the appearance of a serious leaf spot disease upon it.

As mentioned above, an attempt to extend cocoa cultivation would be seriously hampered by the necessity of eradicating Witch Broom Disease. The danger of Panama Disease spreading should an increased cultivation of the Gros Michel Banana be attempted, necessitating the importation of suckers, is too well known to need further stressing.

THE CULTIVATION OF ORCHIDS.

BY

R. DE KERSTING,

Georgetown, British Guiana.

An amateur myself, I would like to see others take up the culture of orchids as a hobby. It costs less to grow twenty-five orchid plants than six rose trees. Instead of tubs, soil and manure, all that is required are a few small pieces of wood, 16 inches long by 4 inches wide. These can be hung by the windows, moved from place to place as required, and when blooms appear, taken into the gallery or drawing room.

Wallaba fire wood can be purchased at 1d. a block from any small provision shop in the City, and is preferable to Calabash, which decays in a short time. Each block is split into three pieces, but it is important when purchasing wood to see that it contains very little sap. If the pieces when split are rough, they must be cut to give an even surface, over the whole of which the orchid roots can spread.

Spaghnum moss is not obtainable in the Colony, and Osmunda is too dry a substance to suit our climate. Growers are therefore advised to purchase a very dry coconut, remove the husk, and shred it well into fibre. Care must be taken that all the dust is not beaten out, as this holds the moisture which is essential to the roots of the orchids. Fibre from half dried coconuts soon becomes sour, and stops the growth of the plant, often killing it.

In mounting the plant, place two handfulls of the fibre from the coconut husk on the block (about 10 inches up). Put the orchid on the fibre, and with the aid of a few one-inch nails driven into the block, fasten the orchid tightly with a piece of copper wire. Never use galvanised wire, as this soon corrodes, and kills the roots. Spray some water on plant and fibre after mounting, drive a nail into the head of the block, and hang it up with a piece of wire. Each morning the plant should be carefully sprayed with water (particularly in the dry season), but too much water may rot it. As the orchid roots start to cover the block, add more fibre to them.

The writer always prefers to hang his orchids in windows facing north, north-east, and east, as then the plants are shaded after mid-day. Orchids never do well facing south or west, but like the morning sun. To ensure their health it must be remembered that a free circulation of air is absolutely necessary, as well as an abundance of light.

If the above instructions are followed, orchids may be grown to satisfaction, and the time and pains bestowed on their cultivation will be rewarded by the production of many beautiful flowers.

Should space be available, an orchid house may be built. Four 10-feet Wallaba posts, at 56 cents each, and 150 feet of greenheart strips, at 2 cents per foot, will suffice to build the frame, 10 feet long by 6 feet wide, which should face east and west. A few coconut branches will serve for temporary shade; then obtain, if possible, some slips of grape vine, which grow very quickly when set. When the vine is about four feet high, transplant it to the head of the orchid house, having previously prepared a hole about two feet deep by two feet wide, filled with broken bottles, loose soil and manure. In about ten months the coconut limbs, by then partly rotted, can be removed, the grape vine having attained sufficient size to give all the shade required for the orchids. During the months of May and December, in the rainy seasons, prune the vine, to produce fresh foliage and better shade for the plants. In course of time, too, the vine will bear fruit. If a grape vine cannot be obtained, a climbing rose of the Maman Cochet variety will soon cover the orchid house and at the same time produce fine roses. Many orchid growers make the mistake of planting vines, the foliage of which is so thick that it obscures too much light and air, both of which are essential to the plants. Under these conditions the orchids will seldom bloom.

The greatest pests of orchids in this Colony are cockroaches, which eat the young roots. They are, however, easily destroyed by Boracic powder, mixed equally with sugar, and placed near the plant. The insects eat this greedily and die.

Orchids imported from England and growing in pots with Osmunda are generally attacked by scale insects in the hot months. It is advisable to transfer them to Wallaba blocks.

It is of interest to note that in March this year, some orchid blooms grown in this Colony (including a number raised by the writer) were sent to the First International Flower Show held at Miami, Florida. They travelled by Air Mail, arrived in perfect condition, and from accounts received subsequently were much admired by visitors to the Show.

NOTES.

Vegetable Gardening:—A plot of land immediately south of the Agricultural Experiment Station, Georgetown, has been selected by the Department for the growing of truck garden crops both to afford occupation to a selected number of unemployed and with a view to establishing a "market garden" near Georgetown.

The area chosen is on crown lands in the vicinity of the Lodge Village; there are 58 allotments of one-fifth of an acre and each allotment is assigned to one farmer, among whom there are 13 ex-soldiers.

The conditioning of the area for vegetable cultivation is directly under the supervision and control of the staff of the Experiment Station. It has been necessary to re-dig the sideline or main drainage trench and to dig an irrigation canal which will be connected to the Lamaha by an intake koker.

In regard to the digging of the main irrigation and drainage trenches, agreements were made with the farmers that Government would pay half the cost of these works if the other half was done by those who intended to occupy the land. This work has now been satisfactorily completed. Each man is, however, responsible for the internal drains affecting his allotment. No charge for rental is being made for the first year.

Banana and plantain suckers, cuttings of imported sweet potato varieties and seeds of various legume crops have been supplied to the farmers for planting.

Certain beds have been selected for demonstration purposes, and methods which have been found at the Experimental Station to be most suited to local conditions will be applied.

The initial arrangements for, and the organisation of, this scheme have presented many difficulties, especially as many of the tenants (who were unemployed) have had no previous experience of agricultural work. It has also been found, which is almost invariably the case in semi co-operative efforts of this nature, that while the better workers progress favourably, there are those who, by their lack of co-operation, prove a danger to the success of the scheme as a whole. Nevertheless, satisfactory progress is being made.

F. B.

The Extraction of Papain from Pawpaw:—In the search for crops subsidiary to sugar and rice, the manufacture of papain, the active digestive principle from the pawpaw, should not be overlooked.

A recent paper by H. D. Sen in the Journal of Agricultural Science describes a number of experiments designed to investigate the factors affecting the yield of papain.

The juice, obtained from the fruit by incising the outer skin, is collected in flat porcelain dishes, filtered through fine muslin and dried in a hot air chamber at a temperature not exceeding 35°c. The dried juice is ground and bottled.

The experiments indicate :—

(1) that the best yields are obtained by giving the fruit four cuts.

(2) that the maximum yield of papain is obtained when the fruit is full grown but not ripe.

(3) that different varieties of pawpaw vary greatly in the papain-yielding capacity.

(4) that the application of organic fertilisers to the soils studied improves the yield of papain.

(5) that potash starvation adversely affects the yield.

The lighter soils of the coastlands of British Guiana appear to be suited to the growth of the pawpaw.

Crude papain exported from Ceylon has a proteolytic activity of from forty to fifty per cent. A purified product may be obtained by dissolving crude papain in water, adding ten times the volume of alcohol and collecting the resultant precipitate of papain.

The utilisation of alcohol, a byproduct of the sugar industry, for the preparation of purified papain for export is a subject which deserves consideration.

R. R. F. S.

Notes on Hides.—The hide of an animal killed for meat is an important by-product of a slaughter house. Lack of care when flaying depreciates the value of the hide. The pithing knife with its straight and sharp pointed blade is not a suitable instrument for flaying ; the hide is frequently scored and even holed by such a knife. The curved flaying knife should be used by all slaughterers.

The tail should be cut off and all flesh should be carefully removed. The hide should then be placed in a brine solution made up of one pound of salt and five pints of water. The correct strength of this solution can be gauged by using what is commonly known, in the Colony, as a white or English potato—the potato should just float in the solution. Allow the hide to remain in the solution for two days. After it is taken out of the solution, cover with fine salt and roll up with the hair inside. The hide is then ready for transport to the exporter or tanner.

Cattle owners should remember that ticks spoil hides. In a tick-infested area they should use one of the proprietary arsenical dipping fluids according to the directions given by the manufacturers. The use of the dip will save the hide and also improve the condition of the animal.

Very many hides are ruined by the branding iron. In many instances the iron is too large, and most frequently the animal is branded on the most valuable part of its hide, namely the quarter.

The iron should be made by a skilled blacksmith and the size of each letter should not exceed two inches. It should be applied to the animal with care, and the operation done quickly or the skin around the brand will slough and a scar will result. The brand should be made on that part of the hide which is of the least value ; suitable positions are (1) the thigh, (2) shoulder, (3) neck.

A system of branding practised in large cattle-breeding countries is to be recommended. In these countries the branding iron is known as the three-piece brand and consists of two letters and one numeral. The first letter represents the district in which the cattle owner lives, the second letter the name of the owner, and the numeral is used when there are more than one owner of the same name ; example D (Demerara), M (Macgregor) 1 —D. M. 1.

The position of the brand on the animal depends on whether the owner is the original owner or the second or third, etc. The original owner places his brand on the left thigh. If the animal is sold, the second owner places his brand on the left shoulder, the third owner on the neck, the fourth on the right thigh, fifth on the right shoulder and the sixth on the neck.

No counter-branding is allowed. Instead of counter-branding, which spoils the hide, a transfer certificate made out on a proper form is used. The buyer may be required to show the transfer certificate and so keeps it filed for reference.

This system of branding and transfer certificates has stopped cattle theft in the countries where it is used, and its chief importance is now for veterinary reasons. An animal dies or is slaughtered and is found to be infected with a serious contagious or infectious disease.

By examining the brands the veterinary surgeon can trace the movements of the animal from district to district and owner to owner until he finds the source of the disease. This is very important for the control of disease.

In the case of owners of large numbers of cattle, five thousand or more, symbol brands are allowed ; these may consist of one letter or any fancy design ; the idea being to reduce the damage done to a hide to the minimum.

T. B.

DEPARTMENTAL NOTES.

His Excellency the Governor has been pleased to appoint Mr. F. Burnett, M.C., M.A. (Oxon.), acting Director of Agriculture, to be temporarily a member of the Legislative Council during the absence on leave of the Hon. J. S. Dash, Director.

During the period under review the acting Director carried out inspections of the work of the Agricultural Superintendents of East and West Demerara, and Essequibo.

Mr. R. R. Follett-Smith, Chemist-Ecologist, visited Plns. Schoon Ord, Tuschen and Ogle, Coverden, Agatash and the Hills Estate.

On April 8, Messrs. Stent and Black, post graduate students in soil science at the Imperial College of Tropical Agriculture, arrived in the Colony on a ten-day visit. During their stay they were given ample opportunity of inspecting the various soil types of the Colony and seeing some of the work of the Department

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Mr. L. D. Cleare, Government Entomologist, paid visits to Pln. Diamond. Ruimveldt, Houston and Port Mourant.

Mr. E. B. Martyn, Botanist and Mycologist, visited Pln. Tuschen together, with the Chemist-Ecologist in connexion with the Coconut Wilt Disease. He also paid visits to the West Bank and Pln. Coverden, East Bank. The latter visit in the company of the Assistant Agricultural Superintendent, was made in connexion with "Plantain Wilt Disease". A visit was also paid to Pln. Port Mourant to inspect a reported outbreak of disease upon cane.

Mr. C. H. B. Williams, Sugar Cane Agronomist, visited the following sugar estates:—Cane Grove, Enmore, Uitvlugt, Leonora, Lusignan, Blairmont and Port Mourant. The experimental work being carried out at the last five estates has necessitated frequent visits, and stays of several days.

Mr. Williams left on June 11 on a visit to the neighbouring sugar producing West Indian Islands. He will visit the various sugar research stations, make collections of new varieties for introduction here, and make himself familiar with the present state of research and the general position of the industry in the Islands.

The following officers of the Department left the Colony on leave:

Mr. C. C. Dowding, Agricultural Instructor, on May 5.

Mr. E. B. Martyn, Botanist and Mycologist, on June 11

Mr. J. A. V. Bourne, Accountant, on June 18.

Mr. A. A. Thorne, Jr., has been transferred from the Treasury to act as Accountant during Mr. Bourne's absence, and Mr. D. D. Haynes, Assistant Instructor, has been appointed to act for Mr. Dowding.

Mr. R. E. Montgomery, Chief Veterinary Adviser to the Colonial Office, arrived in the Colony on an official visit on April 13 and left on May 2.

Major T. Bone, Government Veterinary Surgeon, returned from his tour of the Rupununi ranching district on April 11. Major Bone's report "of a tour of the savannahs of the Rupununi District and cattle trail" has been published in Sessional Paper No. 6 of 1931.

An Agricultural Conference was held at the Director of Agriculture's house Botanic Gardens on June 15, 16 and 17.

The Conference was opened at 11 o'clock on Monday by His Excellency the Governor, Sir Edward Denham, K.C.M.G., K.B.E., under the chairmanship of the acting Director, Hon. F. Burnett, M.C., M.A.

The subjects for discussion on the respective days were

(1) Agricultural Co-operation.

(2) Village Agriculture.

(3) The Rice Industry,

A full report of the proceedings has appeared in the local press.

Mr. J. A. Jameson, post graduate student, attached to the Empire Cotton Corporation, who was until recently studying at the Imperial College of Tropical Agriculture, visited the Colony from June 10 to 12. He was shown the laboratories, the Stock Farm, the Experimental Fields and Sophia Sugar Eperiment Station. He also visited the Botanic Gardens and the West Bank and West Coast Demerara.

PLANT AND SEED IMPORTATION.

THE FOLLOWING ARE RECENT INTRODUCTIONS BY THE DEPARTMENT OF AGRICULTURE.

DESCRIPTION	QUANTITY	WHENCE RECEIVED
Economic.		
Kenya Standard Wheat	1 lb. 14 ozs.	Department of Agriculture, Nairobi.
„ Governor „	1 lb. 5 „	
K 2 R 5 (L.2) „	1 lb. 3 „	
B. F_2 36. C 1 (L) „	1 lb. 11 „	
Subterranean Clover Seed	3 lbs.	Department of Agriculture, Tasmania.
Black Eye Peas	500 „	Department of Agriculture, St. Vincent.
Citronella	100 cuttings	Department of Agriculture, Ceylon.
Budwood.		
Duncan Grapefruit	500 buds	Department of Agriculture, Trinidad.
Marsh „	500 „	do.
Parson Brown Orange	200 „	do.
Duncan Grapefruit	400 „	Department of Agriculture, Dominica.
Marsh „	200 „	do.

EXPORTS OF AGRICULTURAL AND FOREST PRODUCTS.

Below will be found a list of the Agricultural and Forest Products of the Colony exported for the first three months during 1931.

The corresponding figures for the same period during previous years and the average for the thirteen years prior to that are added for convenience of comparison.

Product		*Average 1916-28*	*1929*	*1930*	*1931*
Sugar	tons	19,980	19,470	12,350	22,662
Rum	proof gallons	679,027	265,462	303,491	268,423
Molasses	gallons	136,297	1,061,117	914,083	1,121,704
Molascuit	tons	418	459	332	Nil
Rice	tons	2,942	4,461	5,693	6,060
Coconuts	thousands	596	79	163	384
Coconut Oil	gallons	6,479	4,965	6,572	7,944
Copra	cwts.	3,666	25,967	15,226	16,360
Coffee	cwts.	2,219	4,386	247	2,007
Lime Juice Concentrated	gallons	301	Nil	330	Nil
Essential Oil of Limes	gallons	15	Nil	Nil	12
Rubber	cwts.	40	Nil	46	49
Balata	cwts.	2,308	864	1,603	1,698
Gums	lbs.	1,022	Nil	Nil	72
Firewood—Wallaba, etc.	tons	2,126	2,335	2,869	2,408
Charcoal	bags	11,019	15,000	12,740	14,910
Railway sleepers	No.	5,027	6,869	3,369	1,050
Shingles	thousands	412	824	519	233
Lumber	ft.	49,693	49,779	27,187	75,728
Timber	cu. ft.	34,815	66,505	49,651	39,213
Cattle	Head	93	19	638	14
Hides	No.	1,744	2,076	1,494	1,448
Pigs	*No.*	*119*	*61*	*289*	*Nil*
Sheep	No.	4	Nil	2	6

CURRENT PRICES OF COLONIAL PRODUCE.

From The Commercial Review, Journal of the Georgetown Chamber of Commerce, Vol. XIV, No. 11, Saturday 30th May, 1931.

SUGAR.

Per 100 lbs. net 3 lbs. per Bag allowed for tare

Dark Crystals for Local Consumption..................$2.80

Yellow Crystals do. do. $3.50

White Crystals...$4.25 to $4.35

Sugar..none offering

RUM.

Imperial Gallon. Cask included.

Coloured, in Puncheons—40 to 42 O.P...(for export).....60c. Hhds. 65c. Barrels 70c.

White, in Hogsheads—10 to 45 O.P....(for local consumption)...........48 to 55c.

MOLASSES.

Per Imperial Gallon. Cask included.

Yellow (firsts)... }
Yellow (seconds).. } None Offering
Dark.. }

RICE.

Rice............per Bag of 180 lbs. gross, $3.25 to $5.00 as to quality.

Paddy..........per Bag of 143 lbs. gross, $1.20 to $1.75

GENERAL.

Gold, Raw,...per oz. $18 to $20.

Diamonds,—pro rata as per quality.......................average per carat $13 to $14.

Timber, Gr. Heart, (Lower grade measurements)...72c. to 96c. per c. ft., for export $1.00 to $1.20 per c. ft,

Do. Railroad Sleepers—(Mora)..$1.68 each

Greenheart Lumber...$110 per 1,000 feet

Crabwood Lumber..$60 to $75 per 1,000 feet

Shingles, Wallaba, 4 x 20 and 5 x 22 inches,.......................$7.00 to $9.00 per M.

Charcoal, Capped for shipment...60c. to 80c. per Bag.

Firewood...$2.16 to $2.50 per ton

Coconuts.........Selects, $12.00, culls......$8.00 M.................Copra, 1½c. per lb.

Balata..................................Venezuelan, none. Local Sheet...38 to 40 cts. per lb.

Cocoa...14c. „ „

Coffee...4½c. „ „

N.B.—Duty payable on value at time of Importation and at Rate of Exchange on day of arrival.

METEOROLOGICAL DATA—JANUARY—MARCH, 1931.

Recording Stations & Months.	Rain-fall.	NUMBER OF DAYS OF RAIN						Evapo-ration.	Air Temperature and Humidity			
									Air Temp.			
	Total Inches.	Under ·10 Inch	·10 to ·50 Inch	·50 to 1.00 Inch	1.00 Inch to 2.00 Inches	Above 2.00 Inches	Total days.	Inches	Maximum.	Minimum.	Mean	Humidity. Mean
Botanic Gardens.												
January ...	1.72	11	5	...	...	...	16	5·18	84·9	75·6	80·2	79·3
February ...	3·09	9	3	2	1	...	15	5·49	85·7	76·7	81·2	77·7
March ...	1·49	6	5	...	...	...	11	7·33	86·5	75·9	81·7	74·9
Totals	6 30	26	13	2	1	..	42	18·00				
Means.	...	...	. .	...	...	...	...	...	85·7	76·4	81·0	77·3
Berbice Gardens.												
January ...	8·31	1	11	1	3	..	16	...	82·5	74·8	78·6	84·7
February .	6 25	2	5	3	..	1	11	...	82·4	75·8	79·1	81·9
March ...	2·29	...	2	2	...	...	4	...	83·9	75·7	79·8	79·9
Totals	16·85	3	18	6	3	1	31	...				
Means.	..	...	..	...	...	...	...	. .	82·9	75·4	79·2	82·2
Onderneeming.												
January	5·32	.	13	1	1	...	15	...	88·6	73·3	80·9	85·0
February ...	4.25	1	3	6	...	...	10	...	88·2	73·5	80·8	85·3
March ..	·87	...	3	...	...	..	3	...	88·5	74·2	81·3	85·9
Totals	10·44	1	19	7	1	...	28	...				
Means.	...	...	...	...	...	...	...	...	88·4	73·7	81·0	85·4
Morawhanna, N.W.D.												
January ...	4·89	9	11	1	1	...	22	...	...	...	...	...
February ...	5·58	5	7	6	..	...	18	.	...	...	...	...
March ...	1·02	6	1	1	...	. .	8	...	...	...	...	...
Totals	11·49	20	19	8	1	...	48	...	...	...	..	...

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BRITISH GUIANA.

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In collaboration with the Officers of the Department of Agriculture.

CONTENTS.

(VOL. IV, NO. 3.)

LIST OF ILLUSTRATIONS.

The

Agricultural Journal of British Guiana.

September, 1931.

EDITORIAL.

SUGAR RESEARCH.

A striking feature of modern life is the increasing tendency for nations, colonies, firms and individuals to co-operate more and more, the one with the other. Science has not lagged behind in this respect and the exchange of information, results and ideas between workers, by means of journals, articles, etc., has undoubtedly been one of the main factors in the rapid progress of research and in its application to the practical problems of life. When an occasion offers to supplement the written word by a visit, an opportunity is afforded of seeing much that cannot be adequately illustrated or described on paper, of observing the practical application of ideas and methods about which one has only read, of discussing with workers on kindred problems the methods, aims and difficulties of their and one's own work.

Such an opportunity was recently given the Sugar Cane Agronomist of this Department when he visited some of the neighbouring Islands in order (a) to study the methods of breeding and experimentation in vogue, (b) draw, from his observations, any conclusions that may be of value in the research work here, (c) introduce any new varieties which may be of value as sugar producers or as canes for breeding, (d) observe the present status of cane husbandry in the Islands and draw therefrom any conclusions which may be useful to local planters.

One of the immediate results of the mission has been the introduction of an important collection of approximately twenty new canes which will form a welcome addition to our breeding material and many of which will be tried out against the local canes.

In the report on this mission, which we present in this issue, the technical details of breeding and experimental work, which occupied the greater part of the attention of this Officer, have been omitted and, instead, a general description given of the state and methods of cane husbandry in the various islands,

Special attention is drawn to :—

(a) The tendency in every island to meet depression by intensifying the research work on its crops with a view to increasing yields and decreasing the cost of production ; this tendency involves a large amount of experimentation and research backed by adequate funds and supported by the closest co-operation and interest of all concerned—planters, scientists and governments ;

(b) The increasing recognition of the value of mechanical tillage, permitting better and cheaper work to be done *at the right time* ;

(c) The contrasts offered between the amounts of fertilizer applied, the spacing distance and the system of laying out heavy, low-lying lands in Porto Rico and British Guiana ;

(d) The attention given to agriculture and animal husbandry in the well-equipped and fully organised system of education in Porto Rico ; and

(e) The vast neighbouring rice market waiting to be captured by a well organised industry.

The problem now is to dovetail in and apply to the work in hand such of these ideas as the funds at the disposal of the Department will allow.

At present the direction in which some of the most satisfactory progress has been made by the Department is in the investigation of some of the major breeding and agronomic problems connected with local cane production.

Varietal and cultural trials are being performed in order primarily to create, and test in each representative sugar area of the Colony, a large number of seedlings annually ; to introduce and test promising varieties from other countries ; to multiply and distribute planting material of the most promising varieties ; to carry out spacing trials ; to investigate the possibilities of under-drainage to determine the parents and crosses most likely to yield valuable commercial canes.

This is an ambitious programme for the staff and funds available, and, while it is possible to begin, the continuation of the work, when the sub-stations are each carrying a complete rotation of variety trials, nurseries, etc., will become difficult. However, a preliminary under-drainage trial with bamboos has already been reaped and has given most promising returns and further results will be available shortly of one spacing, two more bamboo-underdrainage and eight variety trials, some of which are being reaped at the time of writing.

Investigations have been started with green manures and efforts are being made to test green manure crops for yield and other characteristics ; to determine the effect of green manures and covers on soil texture, weed control and yield of cane ; to multiply and distribute seed of the best varieties. Under present conditions this work must necessarily proceed slowly on account of lack of funds,

Comparative field tests of different varieties of green manure versus no green manure, of green manure versus flooding or in various combinations therewith, could and should be carried out on the Estates, under the supervision of the Station, but the present staff and budget do not permit of this being undertaken.

Work is also in progress to ascertain the value of rice straw and cane trash as mulches and weed inhibitors, to develop methods of using the same in estate practice, to produce synthetic farmyard manure and to determine methods of incorporating organic matter into the soil.

In relation to manurial experiments, it is possible that the results of Harrison's experiments, confined as they were to a limited area, are not entirely applicable to the whole sugar region. If a broad soil survey show marked difference in the soils of various sections, it will be advisable to carry out careful work in different regions to determine the optimum quantities of nitrogen, phospheric acid and potash to apply and the forms in which these should be given.

A commencement has already been made in this direction and a number of manurial and liming trials have been started at various points throughout the sugar belt. Four of these new trials have been reaped to date—one at Uitvlugt, West Coast, Demerara, two at the Sophia Sugar Experiment Station, East Coast, Demerara, and one at Blairmont, West Coast, Berbice. Another large manurial trial is now being harvested.

Soil samples from the plots in which variety and manurial trials have been laid down have been collected, and it is hoped that the results of these examinations will be of considerable assistance in the future advisory work.

The problem of flood fallowing has received some preliminary attention and soil surveys of two sugar estates have been carried out.

A consideration of the foregoing must abundantly indicate how complex are the factors bearing relation to and controlling fertility. Soil fertility is frequently regarded as synonymous with productiveness, but there is a fundamental difference between the two, since fertility bears relation to the soil alone while productiveness depends partly on the soil but largely on causes external to the soil. Thus, although a soil may be capable of yielding the best results under proper treatment, such a soil will be productive only in proportion to the treatment which it receives.

It is the function of science to study the problem of soil fertility ; it is the art of agriculture, sometimes under most adverse circumstances, to turn fertility into productiveness. When the soil conditions are made closely to approach the requirements of the crop then the soil is said to be fertile.

In endeavouring to make a soil fertile therefore the agriculturist must endeavour to ascertain the exact requirements of his crop. Plants breathe, absorb water and take in food material in solution through their roots. Although the plant breathes through the leaves the roots of the plant

must also be in contact with the air; the roots cannot have this contact unless there are spaces in the soil through which the air can enter, and it is thus that the fertility of the soil is connected with this phase, and it is unnecessary here to emphasise how direct is the control of the soil on the crop's ability to absorb water and dissolved food material.

Among the various attempts to study local soil fertility, one of the most important is the enterprise recently undertaken by Messrs. Booker Bros. McConnell & Co., one of the Colony's largest sugar producing firms, to carry out a soil survey of their cane lands. Mr. J. F. Williams, Dip. Agr. (I.C.T.A.), has been appointed by the above-mentioned Company to pursue investigations under the supervision of the Soil Division of this Department for a period of two years on the cane soils, throughout the Colony, in which this firm has interests.

It is gratifying to be able to record an undertaking of this nature, especially at this period when every effort is being made to reduce expenditure in the sugar industry in all directions. It is felt with some measure of assurance that nought but good can accrue from such an undertaking.

This, briefly, is the position of the work in hand bearing on sugar investigations; how profoundly the results of these experiments will affect the practices of cane culture in this Colony time alone will tell.

REPORT ON A VISIT TO CERTAIN WEST INDIAN SUGAR PRODUCING ISLANDS.

BY

C. HOLMAN B. WILLIAMS, Dip. Agr. (I.C.T.A.),

Sugar Cane Agronomist, Department of Agriculture, British Guiana.

I had the opportunity, during June and July last, of spending eight days in Trinidad, eighteen in Porto Rico, four in Guadeloupe and fifteen in Barbados, visiting the centres of sugar cane research and as much as possible of the commercial cultivation. Some of the observations made and data collected are presented in the following pages. The technical details of the research work which occupied most of my attention will only be touched on lightly as it is not of great interest to the general reader and would make the report unnecessarily bulky.

At the outset, I desire to record my keen appreciation of the help and courtesy extended to me by numerous agriculturists, both Government and private, of the neighbouring islands. All those with whom I came in contact did their utmost to make my trip a success, but I am especially indebted to the following gentlemen :—

TRINIDAD.—Messrs. G. A. Jones, P. E. Turner and G. L. Spencer of the Imperial College of Tropical Agriculture ; J. H. Taylor of Orange Grove Estate ; G. W. Westwood and J. Potter of the Usine Ste. Madeline ; R. O. Williams of the Department of Agriculture ;

PORTO RICO.—Messrs. R. Fernandez-Garcia, R. Richardson-Kuntz, F. Chardon and T. Bregger of the Insular Experiment Station ; L. A. Serrano of the Isabela Sub-station ; T. B. McClelland and R. Davis of the Federal Experiment Station at Mayaguez ; R. McConney, A. Cozier and R. Bermudez of the Fajardo Sugar Company ; O. Roussel-Dupré of Central Mercedita ; M. J. Oben and M. S. Baker of Central Aguirre ; E. H. Barrow and O. Proverbs of Central Guanica ; M. Sulla of Central Eureka ;

BARBADOS.—Messrs. R. W. Miller and C. C. Skeete of the Department of Agriculture.

TRINIDAD.

VARIETIES :

The cane varieties most grown are B. H. 10 (12) and Uba. Numerous thick and thin canes are under trial and others beside the two mentioned are to be found in commercial plantings, but as a general rule B.H. 10 (12) is preferred

wherever and whenever a thick cane will thrive, while Uba is used on less satisfactory types of soil and in rotation with B.H. 10 (12) where the soil will not yield well if a noble cane is grown continuously.

The thick cane which is now attracting most attention as a possible rival of B.H. 10 (12) is P.O.J. 2878. Some thriving fields of this were seen, and in preliminary experiments the cane has shown fair promise, but some tests have been disappointing and sufficient data have not yet been collected to enable a pronouncement to be made as to whether it is going to be better than B.H. 10 (12).

P.O.J. 213 is making a place for itself among the thin canes and may eventually replace Uba. Some good fields of this variety were seen. There were also a few fields of Co. 213. Both these canes have been introduced into British Guiana. Of the Coimbatore canes tried at Ste. Madeline, Co. 224 seems most promising. This and B. 39, a noble cane which has shown up well in variety tests, will be forwarded here later in the year.

With regard to the relative merits of some of the thin canes, one general manager said his experience was that :—

Co. 213 is a good field cane, but about 20 per cent. worse than B.H. 10 (12) in the factory.

P.O.J. 213 is similar to Co. 213 in agricultural yields, but only about 10 per cent. worse than B.H. 10 (12) in the factory.

P.O.J. 234 is a good factory cane but it requires a light sandy loam.

An interesting development with Uba in the past few years, is the discovery that it pays to leave over Spring plantings (*i.e.* crop plantings, there is only one grinding season in Trinidad—February-May) and ratoons cut late in the crop for the next grinding season but one. Thus if a plant cane field be reaped in May 1931, or a field of Uba be planted, it is now the custom on some estates to leave these fields over until the crop of 1933. At this time, when they will be close on two years old, they will give a much heavier tonnage than if reaped in 1932.

Of the Trinidad seedlings, none has shown itself superior to B.H. 10 (12) but the Department's officers consider that T. 1198 and T. 2020 (a seedling of B. 6835, the mother of B.H. 10 (12), S.C. 12 (4), etc.) are worthy of trial here and cuttings will be forwarded later in the year.

CULTIVATION:

A large amount of implemental tillage is done on Trinidad estates. There are at least three lots of cable tackle in the island, but caterpillar tractors are very

popular especially in undulating districts. The following figures were obtained by one concern in a large scale field trial with Uba plants :—

	Average yield of cane per acre, Tons.	Sucrose per acre, Tons.	Field costs per acre, $	Field costs per ton Cane, $
Ploughed :	36.16	5.08	69.16	1.91
Forked	27.65	3.78	65.88	2.38

The field had previously been planted to Uba. In ploughing the beds were not destroyed. The old drains were retained but they were re-conditioned and cleaned for the new crop. The disc plough used, pulled by a Holt 60, tilled thoroughly to about 12 inches. The following is the detailed cost of the various operations :—

	Ploughed land. per acre.	Forked land. per acre.
Preparing lands (grass banking, etc.) ...	$ 2.94	$ 2.94
Ploughing	9.18	...
Digging Para Grass	.11	.11
Drilling (half-banking and forming rows)	5.00	5.00
Round Ridging (giving camber to beds) ...	6.34	6.34
Planting	5.07	5.07
Pen Manure	7.66	7.66
Green Manure	.91	.91
Draining	14.62	14.62
Weeding (twice)	5.62	5.62
Destroying pests	.58	.58
Reaping	11.13	11.13
Forking and stumping out old Uba stools	...	5.90
	69.16	$ 65.88

One factory reports that making rows by hand costs $6.50 per acre. With furrowing ploughs the operation can be done for $1.69 (including 30 per cent. depreciation, etc.), plus additional touching up by hand later at $1.20 per acre.

On one place 190 acres were ploughed with Maclaren tackle during 1930. The cost per acre was :—

Ploughing	$5.80
Chiselling	6.00
Ridging (furrows for planting) ...	2.40

The engine driver gets $1.70, the ploughman $1.10 and the signalman $1.00 per day, respectively.

The same concern ploughs about 1,400 acres annually with 60 h.p. Holts (10-ton). One machine does about three acres per day at a cost of $6.50 per acre.

Inter-row cultivation with a 30 h.p. caterpillar tractor, doing an average of 4 acres per day, costs $1.50 per acre. 30 per cent. should be added to the above figures for depreciation, overhead, etc.

At Orange Grove, Mr. Taylor is using a self-hoisting plough attachment designed by himself and Mr. Massy of 35 Marine Square, Port-of-Spain. This permits of ploughs or chisels being lifted from the ground so that the caterpillar tractor can turn without loss of space and can work up and down on a single bed. The illustration gives some idea of the arrangement which is essentially a winch operated by the same engine that drives the tractor. Similar contrivancies are used in Porto Rico and, I understand, Hawaii. On this Estate chiselling is done to a minimum depth of 15 inches at $7.00 per acre (including 20 per cent. for depreciation, overhead, etc.).

It is a standard practice over large areas to grow green manures on the banks between rows of cane and turn them in when the canes are being weeded and the banks "broken." *Canavalia* sp. and *Crotalaria juncea* are popular for this purpose.

Over large areas the distance of planting favoured is : rows 4 ft. apart, plants spaced 2½ ft. apart in the rows.

Large quantities of farmyard manure, made up under mules, oxen and bison, are used. An effort is made to give all plant canes 20 tons per acre. It is interesting to note that bison are greatly favoured in Trinidad and they appear to be replacing ordinary Zebu cattle. One place reports that the bison carts will haul four tons of cane per day at a cost of twenty-five cents per ton. Under similar conditions mule carts will haul 6 tons per day at 20 cents per ton. There is an economy with cattle carts, however, in regard to harness, feeding, importation of new stock, etc.

In crop time bison, at one estate, are given cane tops and, when working, 2 lb. coconut meal per head per day. In the wet season they live on grass, scrub, etc. For bedding they have trash and loose bagasse. A pen of 60 animals will yield about 2,000 tons of manure per annum, in two clearings, the manure being allowed to collect under the feet of the animals. At the same place the mule pen is cleaned daily and each mule recieves, in addition to the usual forage ;

2 lb. grain (maize) (1 lb. in wet season).

2 lb. of a 3:1 coconut meal and oilmeal mixture.

A sturdy ditching machine was observed in use at Ste Madeleine. Its general outline was that of a double mouldboard plough. I was informed that the cost of digging drains had been materially lessened by its use and the operation speeded up as the machine takes out the major portion of the dirt and the drain has only to be finished off by hand.

The yield of cane is not high in Trinidad. The average seems to be about 20 to 22 tons per acre.

EXPERIMENTATION.

Hardy and his colleagues have already made most important contributions to our knowledge of cane ecology and the study of tropical soils. Williams, Urich and others have made a close study of the insects, especially froghopper, affecting cane. Jones, Brunton and their co-workers have conducted long and careful experiments of which the industry is only beginning to reap the benefit, but there is no slowing down in cane research in Trinidad. Numerous manurial, cultural and varietal experiments are being carried out under the direct control and supervision of the Froghopper Committee, the Department of Agriculture and the Imperial College of Tropical Agriculture as well as, independently, by the estates themselves. Data from the experiments reaped in 1931 were being collated during my stay, while a great deal more information is expected to be gleaned from next year's trials. These results are awaited with great interest for the complex series of experiments in progress are likely to throw considerable light on the question of cane manuring with and without limestone and/or farmyard manure and especially on the technique of field experimentation with cane, for many of the trials are experiments on experimentation. It is unnecessary to go into details on these points here. Suffice it to say that I was exceedingly glad of the opportunity afforded me to see these trials and discuss problems of layout and experimentation on the spot with those responsible for their execution.

For the moment little or no cane breeding work is being undertaken in Trinidad.

It is interesting to note that in an experiment on one estate, where doses of 30, 60 and 90 lb. nitrogen per acre were applied to first ratoons, the effect was marked on that crop and there was a measurable residual effect on the second ratoons. However, the second ratoons appear to have used up all the fertiliser as there was no response in the 3rd ratoons.

Where doses of 5, 10 and 20 cwt. of sulphate of ammonia were applied to first ratoons, there was a response from all the doses, but 10 and 20 cwt. gave no better yield than 5. The experiment is being continued in order that residual effects may be noted. In the meantime a similar trial has been started on plant canes, the application in each instance being given in two equal doses, one at each rainy season.

MANUFACTURE.

No special attention was given to this phase. However, the following data rom one factory, grinding about 67 per cent. noble cane and 33 per cent. Uba may be of interest:

	1927 (Wet)	1928	1929	1930
Tons of Cane per ton of sugar ...	10.95	9.36	8.45	8.70
Average tons of cane ground daily (24 hours)	2862	2894	2921	2880
Average tons of cane ground per hour	119	120	122	120

Average Composition of Factory Juice.

	1929
Sucrose	16.21%
Glucose	1.04
Purity	83.91
Reaction pH	5.4

		1929	1930
Recovery :	% Extraction of Sucrose in Cane ...	94.85%	94.95%

Maceration : 30/35% of water on weight of cane. Temp. 170° F. Condenser water from evaporator calandrias used.

Defecation : Cold liming ; heating to 216° F. Reaction of settled juice pH 7.0 to 7.4 (Reaction of final syrup pH 6.8–7.0).
Dorr settlers and tanks.

Concentration : Quadruple effect evaporators.

Sugar Products		1929	1930
Raw Sugar ...	96° Pol. ...	89.15 per cent.	87.58 per cent.
Yellow Crystals ...	98° Pol. ...	4.60 " "	8.57 " "
Washed Greys ...	98° Pol. ...	6.25 " "	3.85 " "
Second Sugar ...	89° Pol. ...	0.00 " "	0.00 " "
		100.00	100.00

White Sugar was made in Refinery *annexe* during last Wet Season by acid sulphitation of syrup.

Bagasse : Contains 45% water and under 2% Sucrose.

Filter Press Cake : Contains 0.7% Sucrose.

One was struck by the large amount of excess bagasse which was neatly baled and stacked in the neighbourhood of this factory.

MISCELLANEOUS.

In addition to the large amount of experimentation going on with cane, experimentation on a scale which demands a considerable amount of staff, time and money and the closest co-operation between planters and scientists, there is evidence of considerable scientific research with other crops. It was not my function to enquire into these matters, but an opportunity was afforded to get some glimpse of the amount of work involved and progress achieved in cacao, citrus and banana research.

In the modern citrus packing shed, the carefully planned citrus experiment station, the low temperature research station, the excellent cacao farm at River, etc., one sees unmistakeable evidence that Trinidad is laying a sure foundation for her future and it is a pleasing feature to note how Government, Planters and Scientific Institutions are all combining to this end even when there can be no doubt, as with cacao genetics for example, that no results can be available for many years, perhaps fifty or more.

PORTO RICO.

Porto Rico is an American Colony with an area of 3,435 square miles and a population of 1,543,913, of whom 1,054,456 are rural. In the ten years 1920–1930, the natural increase in population has been a quarter of a million. The principal crops and the approximate area planted to each are :—

Cane ...	...	255,000	acres	
Tobacco	...	29,000	„	
Coffee ...	...	172,000	„	(much of this was destroyed by the San Felipe hurricane of 1928).
Pineapples	...	2,700	„	
Grapefruit / Oranges	...	6,000	„	
Minor fruits, etc.	...	96,400	„	
Coconuts	...	10,200	„	
Pasture	...	1,077,600	„	
Forests	...	372,000	„	
Miscellaneous	...	64,000	„	

The largest cities are :—

San Juan	...	114,715	inhabitants.
Ponce ...	...	54,000	„
Mayaguez	...	37,000	„

In addition there are some 21 other towns varying in population from 5,000 to 14,000.

There is a fine network of modern motor roads, usually lined with flowering and shade trees, some 220 miles of public railway and about 1,000 miles of private line belonging to sugar factories. There are, of course, numerous harbours and many of these are ports of entry maintaining direct communication with the outer world.

Telephone, telegraph and electric circuits cover the whole island and help to make rural life less burdensome, while "talkie" theatres are numerous and always within easy reach.

Education is free and compulsory and the large, airy, modern schoolhouse, built of stone or reinforced concrete, is a prominent landmark in every town and village. The country being officially bilingual (although Spanish is the common, almost universal, medium of intercourse), the junior classes are taught in Spanish and take English as a subject. The senior classes, high schools and University teach in English and take Spanish as a subject.

At the University, there are 1,300 students of both sexes. The Colleges of Liberal Arts, Education, Law, Pharmacy, and Business Administration are situated at Rio Piedras, the Colleges of Agriculture and Engineering at Mayaguez, and the Graduate School of Tropical Medicine at San Juan. The Colleges of Agriculture and Engineering have 300 students of whom two-thirds are usually in agriculture. The course is a four-year one leading to the B.S. degree.

In the course of conversation with the Chancellor of the University I learned that an important modification is shortly to be made in the course of studies. Instead of four years continuous college work, it is now proposed to give the men two years training in the fundamental sciences underlying agriculture and a certain amount of preliminary training in the art. Then the third year will be spent on an approved farm or estate. At the end of this year, the student will have to pass a stiff practical examination in the work he has been doing. If he succeed, then he will be allowed to return to the University and specialise for his fourth year in the crop or branch of scientific agriculture in which he is most interested.

I understand that the College of Agriculture costs about $600 per annum per student. Tuition is gratis but students pay their own board in the neighbouring town of Mayaguez. Books are sold at cost and there are a few minor charges for laboratory fees, etc. It is estimated that a student should spend at most a total of $250 to $275 per college year.

The college has a good library and appears to offer ample laboratory facilities. There is a model dairy, etc., and well equipped workshops for students in steam and electrical engineering, woodwork, etc.

In rural districts there are some 35 schools especially equipped with land, stock, etc., for teaching farming and animal husbandry, and these are helping to stem the rush to the cities. They appear to me a very useful and promising

feature. In addition, there are ten demonstration farms scattered over the countryside. These all carry a certain quantity of high-bred stock which serve to improve the breeds in the district. Their pens, stalls, feeding, etc., serve as object lessons to the peasantry who come for advice and for seed. The plots of different crops grown serve as sources of seed, give yield data for the district and are used for demonstrations to farmers and school-children, these latter being regularly brought in by their teachers.

Apart from these there are several stock farms, looked after by the Veterinary Department, dotted about the island.

THE INSULAR EXPERIMENT STATION.

This important organisation at Rio Piedras functions as a part of the Department of Agriculture and Labour, and is supported by the Insular Government. Its staff consists of a Director, and a highly trained technical staff divided up as follows :—

Chemistry Division	...	...	6
Agronomy ,,	...	...	5
Entomology ,, ...	...	...	2
Pathology and Botany	...	...	3
Veterinary Division	...	...	3
Isabela Sub-station	...	...	5

The annual appropriation is about $100,000 and the Station is very fully equipped and housed in commodious concrete buildings and laboratories with fireproof library, etc. Separate funds are voted for maintaining a Veterinary service, Plant Quarantine officers, District Agricultural Officers and Advisors, model farms, farm schools, horticultural experiments and the horticultural nurseries at Trujillo.

A great deal of cane breeding is done here and after preliminary tests the better varieties are taken to the estates where they are thoroughly tested by the Agronomy Division of the Station both for yield under the various soil and climatic conditions and for resistance to disease. Mosaic disease being of considerable importance, it is usual to conduct a mosaic infection test alongside each variety test.

The Isabela sub-station is situated in the North West District where, within recent years, a large irrigation project has been started. It concerns itself with finding suitable crops for the district and working out satisfactory methods of culture, rotation, etc. It is well worth a visit and I was especially interested in the carefully planned and ingeniously executed irrigation experiments being carried on with sugar cane.

THE PORTO RICO AGRICULTURAL EXPERIMENT STATION.

Situated at Mayaguez, near the Agricultural College, this Station is supported by the Federal Government and has a staff consisting of a Director, Horticulturist, Parasitologist. Plant Pathologist, Plant Breeder, Chemist and the usual assistants. The annual appropriation for its upkeep is $70-80,000. Here too a great deal of cane breeding is being done, and it was my privilege to see a large number of promising Java-West Indian hybrids. After the preliminary tests the likely canes from this Station are given out to co-operating planters for a more searching test on the estates.

THE GUAYAMA STATION.

Near Guayama in the South East of the Island a station is maintained by the Federal Government for the preservation of all cane varieties which have been in commercial cultivation or which have been used or are likely to be used for breeding purposes. Among the hundreds of varieties to be seen here are some of the canes brought back by the Brandes expedition from New Guinea.

THE FAJARDO STATION.

This station, maintained and run by the Fajardo Sugar Company, works in close co-operation with kindred Government institutions. It has been in existence for many years and has had the good fortune to have a succession of enthusiastic well-trained technical men on its staff. As a result of continued and well-directed effort, this Station has fully justified its existence and has made very notable contributions to cane breeding and cane experimentation in Porto Rico. Even in the present crisis there is no tendency to hamper its activities, and it promises to be no less fruitful in the future than in the past.

VARIETIES.

The favourite cane of Porto Rico is, undoubtedly, B.H. 10 (12). The Porto Ricans claim that this variety has been the salvation of their industry. Nevertheless large areas are planted to P.O.J. 2725 and Uba in dry areas, where irrigation is not available and also where Mosaic disease is bad ; to S.C. 12 (4) in the more elevated valleys where the soil is lighter and poorer and temperatures lower ; and to P.O.J. 2878 which is being given a thorough tryout on a large scale, several thousand acres being now under cultivation for the 1932 crop. So far tonnages from P.O.J. 2878 have been, for the most part, very satisfactory, germination good, growth rapid and ratoons very satisfactory, but there is a tendency to uprooting with even moderate winds and there are some unpleasant surprises from the juice sometimes. On the whole no one is prepared yet to commit himself to a definite statement on this variety until more is known about it under local conditions.

The area under Cristalina, P.O.J. 36, D. 433 and D. 109 is declining, while certain new varieties like F.C. 916, P.R. 803, etc., are being extended. Practically all cane breeding work in Porto Rico to-day tends to combine the vigour and disease resistance of the Java canes with the sweetness and other desirable characteristics of the best West Indian canes. Methods, plans, results, etc., were freely discussed with those responsible for the work of breeding and testing new varieties. Details will not be gone into here but it should be noted that the results obtained are very promising and the following varieties have been introduced for trial here and are now in quarantine :—

P.R.	803	F.C.	916	M.P.R.	63	M.P.R.	42
,,	807	,,	998	,,	49	,,	44
,,	820			,,	151	,,	132
,,	826			,,	7	,,	145

CULTIVATION.

Large sections, especially on the South Coast where the rainfall is usually under 40 inches per annum, grow cane under irrigation, but many factories have to rely entirely on rainfall. On the other hand, there is a considerable area of low-lying land which is flat and difficult to drain. There are therefore, roughly three types of cultivation to suit, respectively, irrigated, non-irrigated undulating, and non-irrigated flat (heavy and low-lying) lands. The irrigation system is said to resemble that used in Hawaii. Deep furrows are used for planting, and these furrows follow the contour lines, so that they are practically level. The planting furrows are intersected every 30 or 40 feet by shallower irrigation ditches which bring the water. By making or removing a little mound of soil at the point where the irrigation ditch crosses a furrow, water can be shut off or let into the furrow at will.

In unirrigated areas where drainage is reasonably good, cane is planted (frequently in continuous rows) in furrows made by a plough. Contrary to the practice in irrigated districts, these furrows are gradually filled in, in the course of weeding and cultivation. In these sections fields are usually divided into beds by drains which may be spaced from 20 to 30ft. apart, depending on topography and rainfall. Few, if any, instances were observed in which any attempt was made to give the beds a camber—a point much stressed both in Trinidad and British Guiana.

In low lying flat lands, where the soil is stiff and heavy, and drainage difficult, Porto Rican cane planters employ a system peculiar to the country and known as the "gran banco" system. Essentially this consists of a series of small beds 8 to 10 feet wide. Each of these beds only carries two rows of cane. The soil from the drains (there is a drain at every other inter-row) is placed on the narrow bed and helps to raise it above the general level of the area. The cane is often planted in holes made with a hoe. The holes are spaced 1½ ft. from the

drain and 3½ ft. apart, the distance between the rows being about 4½ ft. Sometimes a shallow furrow is made by a plough and the canes planted therein. In making this furrow, one on either side of the grand bank, about 18 inches from the drain, care must be taken not to fill up the drain. The ditches which divide these beds are 12 to 15 inches deep and about 15–18 inches wide at top. They are sometimes made by ploughs and finished by hand, sometimes made entirely by hand with a draining shovel. At one place drains 16 inches deep and 8 ft. apart were being made with two cuts of a single mouldboard, one of a double mouldboard and finishing by hand at $5 per acre. Another estate was paying $15 per acre for a more carefully made drain 18″ wide x 18″ spaced 18 ft. apart. Another estate, in the irrigated region, was paying $8 per acre for drains 12–16″ deep and 12″ wide at top spaced 20 ft. apart and $16 per acre for the same drain spaced 10 ft.

The usual distance between rows of cane is four to four and a half feet and the cane is planted, for the most part, continuously, or semi-continuously, in the rows.

The general yield for the island is about 3.4 short tons of sugar per acre but, as will be seen from the following figures, there is great variation :—

Central A : 32 tons cane, or 3.56 tons sugar ; 27% plant canes : remainder ratoons to fifth ; cane rain-grown, 60-70 inches per annum.

Central B : Four years ago the cane yield was 16 tons per acre and the factory rendiment 8.5. This year the average yield was 32.7 tons cane and the rendiment 11.37. About 10% of the land is irrigated, on the remainder the canes depend on an annual rainfall of 70-80 inches. Ratooning is done up to third.

Central C : This factory only has about 30% ratoons and these are all first ratoons. The average figures from 3,473 acres cut last year were 47.087 tons cane and 6.411 tons 96° sugar per acre. This year the average yield was only 42.625 tons cane per acre. Practically all the cane is irrigated.

Central D : Practically all the cane is grown under irrigation and only first ratoons are kept. These amount to about 31 per cent. of the crop. In 1930 this Factory gave Fall planted cane 22 irrigations, Spring planted cane 19 and ratoons 14 ; irrigation expenses amounting to 45% of the cultivation costs (including manures but excluding staff salaries). An average of 8.7 acre feet of water was used per acre. The following are the average figures for 1930 :—

	Group A (8,344 acres)	Group B (2,633 acres)
Tons sugar per acre (general average)	6.82	6.96
„ cane per acre (Autumn plants)	70.34	73.63
„ sugar „ „ („ „)	8.74	8.68
„ cane „ „ (Spring plants)	49.94	51.96
„ sugar „ „ („ „)	6.68	6.62
„ cane „ „ (Ratoons)	40.95	48.37
„ sugar „ „ („)	5.60	6.37
In 1931 the general average yield was	42.31	46.81
In 1930 „ „ „ „ „	51.89	55.57
In 1916 „ „ „ „ „	27.60	25.43

About 23% of the area reaped is in Fall Plants, 46% in Spring Plants and 31% in ratoons. The tons cane per acre put on per month of growth were :—

Ratoons	3.32
Spring Plants	3.81
Fall Plants	4.27

Central E : (section I). 717 acres B.H. 10 (12), 169 acres P.O.J. 2878, 61 acres P.O.J. 2725, 921 acres P.O.J. 36 and 302 acres Uba gave, this year, an average of 36.66 tons cane from 549 acres of Fall plants, 144 acres of Spring plants and 1,477 acres of ratoons (down to third). Most of this cane is rain-grown under 75-80 inches of rain per annum.

Central E : (section II). Cane is grown here under 100 inches of rainfall. About ¼ of the area is in plant canes, the remainder in ratoons down to third. Some years ago the yield was 12 tons of cane per acre. Last year it was 31 and this year 36.

The usual application of fertilizers appears to be about 800-1,000 lb. per acre in two doses, the same treatment being given to both plants and ratoons. The first dose usually consists of a mixed mineral manure. Some use a 12 : 8 : 4 formula, others a 10 : 6 : 16, others 13 : 5 : 10; and others a 14 : 6 : 8. The second dose is usually sulphate of ammonia alone. One large irrigated estate gives another 400 lb. of sulphate of ammonia per acre to half its *Gran Cultura* (Fall) plants. Apparently the most common practice is to cover the fertilizer either by putting it in a hole made with a hoe or, what is more usual, in a small furrow made with a plough and closed in again after the manure has been applied. Sometimes sulphate of ammonia is applied on the surface but the mixed manures are almost invariably incorporated with the soil.

A good deal of both tile and mole drainage is being done in Porto Rico. Some places were using a 4″ diameter mole and others a 6″. In both instances,

satisfactory results are obtained with the first crop of canes but there is a tendency for the drain to fill in after this and it is often found necessary to open surface drains in the ratoons. One estate reports that after burning off trash the field is ploughed with discs, then knifed with a Killifer to a depth of 12–20 inches, and then the mole drains are put in. A 60 H.P. tractor is able to put in a 6″ mole drain, 2 ft. deep, every 12 ft., on 20–25 acres per day at a cost of about 60 cents per acre (gasolene at 18 cents per gallon.) Central B has tried both 4 inch and 8 inch moles. The latter required a much more powerful tractor and so far there is no difference obvious in the effect. On the other hand they have been able to attach a mole to a furrowing plough and make 12″ deep planting furrows and a mole drain 12″ below at a cost of \$3.00 per acre for the double operation. A certain number of open drains are still used in mole-drained fields to take off surface water.

Tile drains are working successfully on several estates and the area so drained is being extended but comparatively few data are available for any great length of time although one factory reported that some drains laid 10 years ago are still giving satisfactory service. These drains are principally used to lower permanently the water table in low-lying sections and to assist in the removal of salt. Sometimes a few open drains are still used to take off surface water. In some low-lying areas it has been difficult to plough in the past and in these there is a tendency for irrigation water to collect and evaporate, leaving a salt deposit. In such circumstances, the use of tiles has enabled cane to be grown at Central C in areas which were infertile five or six years ago. Central D reports that fields tile-drained four years ago are now giving good yields while some that had had to be abandoned for eight years are now yielding 65 tons of cane per acre after tile draining. At Central B there is an area of 40 acres drained three years ago at a cost of \$125 per acre. The tiles were made on the estate and are of baked clay. The main pipes are 12 inches in diameter, the others 4 inches. The smaller pipes are 2 ft. below the surface of the field. The system is said to be very effective and the soil appeared well drained when I visited it after a spell of rainy weather. During the dry weather, however, the canes suffered as the drainage was, apparently, too thorough.

At Central C tiles are made of a 3:1 sand and cement mixture. One bag of cement is said to make about 75 tiles four inches in diameter and one foot long. The sand and cement are hauled to the point of manufacture and the tiles are made by task at ½ to ¾ cent per tile. A machine can be purchased for \$140 which will make about 250 tiles per day. After curing ten to fourteen days the tiles can be hauled and transported with but nominal breakage. The ditches for tiles are made by hand as this estate has not enough land to tile-drain to make it worth while to go in for a good ditching machine on caterpillar track. It is said that machines can be purchased for \$6-8,000 which will move on comparatively soft ground and dig 100 ft. per minute. In very wet fields tile drains are as close as 15 ft. apart. In more favourable circumstances they may be 50 to 100 ft. apart. The

depth at which the tiles are placed varies with the circumstances from two to four feet. At the wider distances the draining can be done at $75 per acre, but at 15 ft. apart the cost may go as high as $250 per acre. Six inch diameter tile mains are as much as 600 ft. long on this estate. This Central usually places gravel on top of the tiles before replacing the soil so as to prevent silting up and in very soft soil a trough of one inch lumber has been placed under the tile to preserve grade and prevent a broken alignment. Tiles were being laid at Central D during my visit and a covering of cane trash was being placed on these before the ditch was filled in. In sandy loams salts are markedly reduced by tile drains in two years but on, very heavy clays it may take four to five years before there is a marked difference even when the Killefer is regularly used. Giles reports from Central Mercedita: "The first field drained by tile at Mercedita was planted to cane in September 1921 the wet part being ploughed for the first time. Previous planting had been in holes made in the banks between ditches. The crop was harvested in 1923 with an average yield of 56 tons cane per acre. The previous record of this field was 1917, 11 tons per acre; 1918, 27 tons per acre; 1919, 21 tons per acre; 1920 28 tons per acre; and 1921, 27 tons per acre.

"One of the inevitable consequences of irrigation is the formation of wet spots in many fields when the subsoil does not provide natural outlet for the surplus water applied. These wet spots after a few years become salty from the continued surface evaporation. Tile drainage offers a practicable means of remedying this condition and the earlier it is applied the better, since once the soil is thoroughly impregnated with salts it may take a number of years to remove the excess so that crops will grow again. Some of the earliest drains installed at Mercedita are still discharging saline water and part of the area drained will not produce cane, but these areas are growing smaller each year and we hope that within a few more years, the whole will be reclaimed.

"An example of this condition is a field near Mercedita factory which has a salty spot near its center. This portion of the field was not planted for some years on account of failure to produce.

"Tile drains were placed in the wet portion in the Spring of 1921.

The previous record of the field was:

1917	...	4	cuerdas	Gran Cultura	40 tons per cuerda
1919	...	7¼	„	„ „	37 „ „ „
1920	...	7¼	„	Primavera	24 „
1921	...	7¼	„	Ratoons	13 „

"After tiling the whole field 10 *cuerdas* were planted but only 9¼ acres were harvested, which gave a crop of 23 tons per acre in 1923 as *gran cultura* although about one-half acre had practically no cane on it. The average for the 10 acres was 37 tons. The non-productive portion is smaller and it is expected that in another year or two cane will be growing on the entire area."

In connection with the salt problem it may be mentioned here that a good deal of Central D's irrigation water comes from wells. The common salt content of this water varies from 3 to 46 grains per gallon. Experiments are being carried out to test the maximum concentration that cane will stand. The indications so far are that growth is adversely affected if the concentration goes over 20 grains per gallon. It is interesting to note that Earle, having tested out a large number of varieties on salty lands at Central Aguirre, came to the general conclusion that the Demerara canes were more resistent to salt than those of Porto Rico or Barbados. He attributed this to the difference in soil conditions in the countries of selection, and it may be that we have in this an explanation of the frequent failure under Demerara conditions (low maritime lands protected from the sea by dykes) of canes selected on the well—drained uplands of the islands.

At the time of my visit a machine for digging surface drains was expected to arrive shortly for trial. I have asked that a report, photographs, specifications, etc., be sent to me.

But little child or female labour is available on Porto Rican sugar estates so that almost all the work is done by men. In view of this, recourse is had to machines for various operations. The latest importation in this line is the Fowler Gyrotiller. One was seen at Aguirre, but not at work as the rains had been too heavy. It completes the ploughing, harrowing and furrowing in one operation and I was told by the estate staff that the work done was excellent.

However, it hardly seems to be a machine that would suit British Guiana. The Gyrotiller weighs 22 tons, has a H. P. of 150, consumes 5 gallons of Diesel oil per hour and is expected to do 8 acres per ten-hour day in large fields at a cost of about $3 per day. The machine costs about $30,000.

At Central B, with a Cletrac 30 or Monarch 35, furrows 12″ deep and mole drains 12″ below the furrow are made for $3.00 per acre. A field for Gran Cultura (Autumn) planting is ploughed in May—June at a cost of $2.50 to $3.00 per acre. Just before planting the field is given another two (or three if the soil be stiff) ploughings at $2 to $2.50 per acre. Draining by plough costs $5 per acre whereas by hand the cost is $15. Planting a single continuous row costs $4 per acre, to which must be added $2.50 for drawing down plants, selecting and transporting. Manuring costs 70 cents per application (400 lb.) if carried out with a plough or $1.50 if all the operations are done by hand. Six to eight weedings are given at $2 to $2.50 per acre. No inter-row cultivation is given to plant canes save weeding, but ratoons are subsoiled every bank. This costs about $1.50 per acre whether done by bulls or tractors but the former only till to 12 inches while the latter work to twice that depth. The average cultivation costs are $69.32 per acre, or $2.12 per ton. To this must be added 98 cents per ton for cutting, loading and transport; so that the cane costs the factory $3.10 per ton (which includes 50 cents per ton for field supervision, agricultural office and general field superintendent).

At Central A field labourers earn about 75 cents per day out of grinding for cutting seed, weeding, etc. Fertilizing gangs make about 60 cents per day per head and the total cost per acre for making two applications, covering, etc., averages $2 to $2.25. At Central D some women are used in manuring. An experienced woman will apply 10 bags per day but the average is about seven bags (200 lb. each.) They earn 12 cents per bag and work from 6.30 or 7 a.m. until 2 or 3 p.m. eating after work. Covering etc., is done by implements at extra cost. A 1,500 acre estate at this Central keeps a manuring gang of six for actually applying the fertilizer. At Central E (Section II) it costs 20-22 cents per bag of 200 lb. to apply manure, 18 cents being paid the labourer and 2 to 4 cents going to pay transport.

In this section ratoons are given two knife cuts at a cost of 50 cents per acre, a 30 H.P. tractor being used and each tractor covering about 8 acres per day. Here it is usual to plough twice, and if possible harrow with discs, before planting. The ploughing can be done at $2.50-$3.00 per acre (including repairs) and the harrowing at 75 to 90 cents depending on the size of the field—the larger the cheaper.

A good deal of night ploughing is done at rush periods and I was informed that no extra wage is paid as the night shift men have the advantage of working under cooler conditions. Working in this manner a Caterpillar 60 ploughed 399 acres at Central E (Section III) in March at an average cost of $1.85 per acre (all in costs, depreciation excepted.) The driver of such a tractor gets $2.00 per 12 hour day.

During grinding most of the work is given out by task. At Central A, at this period cultivation labourers earn about 85 cents per day, cane cutters $1 to $1.15, loaders $1.25-$1.40 and drainage men $1.00. Here it is usual to have 16 loaders behind 50 cutters. These will cut and load 100 tons per day, always leaving over a certain amount of cut cane for the next day, for the cutters cut 3 to 5 tons per head. Cutting works out at 35-36 cents per ton, while cutting, loading into small trucks, haulage by a small gasolene engine to the main loading stations and loading into the factory trucks costs about 74 cents per ton. At Central B when Uba is burned it costs 40 cents per ton to cut and load, if unburnt, 75 cents. Labourers here cut about 5 tons per day.

At Central E (Section II) the average rate of cutting, topping, cleaning and cutting into 3-4 ft. lengths is one ton per man per hour. If bull carts are used for transport the carters load the canes. If portable track be used loaders have to be paid but the final costs are about the same as for the bull carts. Tracks are put 100 ft. apart, two men laying sufficient track in a day to take off at least 150 tons cane. A loader here can fetch 8-10 tons of cane per day and earn about $2.00. This estate gives about six weedings at an average cost of $2.00. Canes are never stripped (trashed) and no weeds are headed out of the fields.

At Central C, three cuts are given ratoons with an Avery subsoiler. For applying manure this estate pays :

35	cents	per	acre	to	open a ditch alongside the canes.
30	„	„	„	„	apply 400 lbs. manure.
40	„	„	„	„	cover with hoes.

Putting down and taking up portable track here cost 6 cents per ton of cane, loading 18 cents per ton, and the hauling of the trucks by bulls out to the main line four cents per ton. The lines are put down 72 ft. apart. Small one-ton cars are used on the portable track. Cane at this Central cost $3.60 per ton delivered at the factory this year. Five years ago it was costing nearly $6.00 and it is estimated that next year it can be delivered at $2.70.

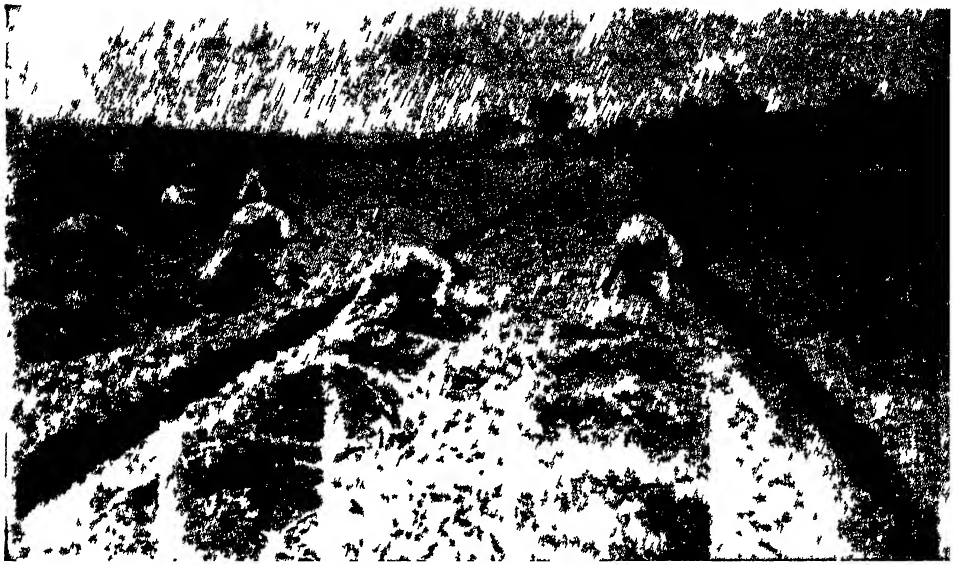
At Central D. cane cost $3.35 per ton loaded into the train. This is made up of :

Preparing, planting, cultivating, managers salaries, roads, etc.	$2.62
Cutting and Loading	.73
	$3.35

Offices. General Manager, Taxes, Rent, etc. are not included in these figures but they include the cost of keeping cattle and repairs to portable track (but not depreciation on the cost of the track). Yields are heavy here and a man cuts five tons of cane per day. On this property one or two cuts with an Oliver No 2 subsoiler are given to all ratoons with a 15 H.P. Caterpiller. This knife penetrates to about 18 inches. Some green manures are used, about 50 acres being planted on each 1,500 acre estate. On the irrigated lands of this Central the burial of trash has given excellent results, the yield being increased by as much as 15 tons per acre on heavy fields where this has been done for three years.

MISCELLANEOUS.

Mosaic appears to be the most important of the cane diseases present in Porto Rico and a good deal of it was to be seen in the Juncos district where, apparently, rogueing had not received all the attention it deserved. P. O. J. 36 is said to be 100% infected with mosaic. Gummosis had been recorded but is not now causing much trouble. Dry top rot, caused by *Ligniera vascularum* is present and can be very serious on certain varieties such as P.R. 801. Pokkah Boeng is most common on the Java canes but does not seem to be important. In another Colony markings were noted on certain Javanese varieties which were so similar to the leaf symptoms of Pokkah Boeng, as pointed out to me in Porto Rico, that I drew the attention of the authorities to them and suggested that specimens be examined by a plant pathologist to see if *Fusarium moniliforme* is present.



After Menendez-Ramos

Planting in holes. Porto Rican *Gran banco* system

After Menendez-Ramos.

Cleaning *Gran banco* drains. Porto Rico

After Menendez Ramos

Trash lined after reaping Porto Rican *Gran banco* system

Photo by *Taylor*

Caterpillar Tractor with Hoist for lifting Ploughs

This year's crop in Porto Rico was badly affected by drought and fell below estimate. The figures for 1930 and 1931 are, respectively, 866,110 and 783,874 short tons.

Factories are reported to be very efficient. At Central D the rendiment was 12.96 in 1930 and 12.76 in 1931. Connected with Central Mercedita is a Suchar refinery which turned out 95,000 short tons of "Snow White" sugar last grinding. I understand that this sugar competes successfully with the best refined sugar on the continental American market. The sugar refined here is not from Mercedita alone; that factory made 28,899 short tons of raw sugar.

Large areas are rented by the sugar companies for growing their cane. The average rental is said to be $15-18 per acre, taxes amounting to another $7-8. In the past Guanica ground about 250,000 tons of cane per annum produced on the Company's properties in Santo Domingo and brought over by steamer. No such cane was ground this year as a duty has been increased on the raw cane coming from foreign countries. However the factory still made 94,031 short tons.

The following organisation (staff) of a section belonging to a large factory may be of interest. The section cuts about 2,500 acres of cane annually and in addition to the General Field Manager of the Company there are, in this section :—

1 Superintendent : about $400.00 per month, house, horse, telephone, light.

1 Asst. ,, : about $200.00 per month, house, horse, telephone, light.

2 Managers : about $100—$125 per month, house.

2 Timekeepers : about $60 per month, house and free medical attendance.

5 Overseers (driver type) : $1 per day, house.

All accidents to labourers have to be reported within five days. Government fixes the awards which are usually paid from a central fund to which all factories contribute. Government has to be shown receipts in order that it may be sure that payments have been made. A field labourer is allowed about 50 cents per day while incapacitated and a lump sum, in addition, if there is a permanent injury. One Central insures all employees earning more than $100 per month.

The soils of the Fajardo Central have a pH of 6.6 to 6.8. Extensive liming experiments have been made and in these, almost invariably, the limed plots gave higher yields. Three tons of limestone makes a markedly significant difference in yield and the property now uses about 7,000 tons of pulverized limestone per annum.

I was able to visit the plant which supplies this limestone and obtained a sample. Mr. Follett-Smith has examined this and finds that 42.2 per cent. passes through a 100 mesh sieve. However, the maker is prepared to guarantee a pro-

duct, 50 per cent. of which will pass a 100 mesh sieve. The chemical composition of this limestone is :—

Calcium carbonate ...	99.20 per cent.
Magnesium ,, ...	0.23 ,, ,,
Oxides of Iron and Aluminum	0.00 ,, ,,
Silica	0.03 ,, ,,
Organic matter	0.54 ,, ,,
	100.00 per cent.

The latest quotation is as follows :—

Product ...	Pulverized Calcium carbonate "Hicaco."
Chemical Analysis	99% $CaCO_3$
Mechanical ,, ...	50% through 100 mesh sieve.
Packing ...	200 lb. net in used jute bags in good condition, properly tied and labelled.
Quantity ...	Up to 5,000 tons (above that quantity a lower quotation may be submitted).
Deliveries ...	f.a.s. schooner Fajardo harbour in cargoes from 200 to 500 tons (Fajardo is a port of entry).
Time allowed ...	A week for quantities up to 500 tons, contingent on humidity of raw material.
Price ...	$6.00 per ton of 2,000 lb.
Terms ...	Cash against shipping documents.

The plant is a modern one which also produces quick lime and slaked lime, their respective compositions being :

Quicklime	%	*Slaked-Lime*	%
Calcium oxide ...	97.96	Calcium hydroxide ...	97.63
,, carbonate ...	1.70	,, carbonate ...	0.77
Magnesium oxide ...	0.19	Magnesium oxide ...	0.25
Iron and aluminum oxide	0.05	Iron and Aluminum oxide	0.32
Silica ...	0.10	Silica, etc. ...	1.03
	100.00		100.00

It may be of interest to rice producers of this Colony to learn that large quantities of rice are consumed in Porto Rico. I was informed, and my own observation and experience confirmed the statement, that rice is a staple food of all classes of Porto Ricans and it can be safely assumed that each one of the million and a half inhabitants of the island eats rice at least once, and very often twice, per day.

GUADELOUPE.

Four days were spent here waiting for a connection for Barbados. All agricultural products are protected by the French tariff and find their market in France. Sugar Cane is the principal culture but a high quality coffee, cacao, bananas, vanilla, etc. are also produced. The main exports for 1930 were :—

Sugar	...	...	24,852 tons.
Rum	...	...	2,836,966 gallons.
Coffee	...	...	163 tons (used to be 700-800 before 1928 cyclone).
Cacao	...	...	104 „ (used to be 600-700 before 1928 cyclone).
Bananas	...	...	2,278 „
Vanilla	...	...	1 „ (used to be 30-35 before 1928 cyclone).

Rum usually has a ready sale at remunerative prices and for many years the extraction of sugar has been looked on as secondary to the manufacture of rum. For this reason the sugar factories are not very efficient and a six to eight per cent. rendiment has been cheerfully accepted since what was lost in the boiling house was found again in the distillery. Quite recently, however, rum sales have slackened and increasing attention is being paid to boiling house efficiency.

In addition to the rum made at the sugar factories from molasses, a great deal is made direct from cane juice by a large number of distilleries. The situation is easily grasped from the following figures :

Average Exports per Quinquennium.

Period Ending	*Sugar*	*Rum*
	Tons	Gallons.
1885	49,555	487,498
1890	46,507	746,878
1895	38,257	685,212
1900	38,628	540,980
1905	36,216	989,318
1910	37,267	1,742,202
1915	35,272	2,543,442
1920	27,143	3,003,968
1925	26,630	2,837,186
1930	22,998	2,719,816

Buffon, from whom these figures are quoted, says this change over from sugar to rum is easily understood when it is realised that one ton of cane will yield the Guadeloupe factory about 154 lbs. of plantation white sugar. At 200 francs. per 100 Kilograms (an average figure) the net proceeds for the factory will be about

\$1.40, to which must be added \$4.40 the net value of 20 litres (4.4 gallons) of rum made from the molasses and sold at an average price of \$36 per 100 litres (22 gallons). The agricultural distillery, on the other hand, will get 75 litres (16.5 gallons) of rum from one ton of cane and this will yield a profit of about \$12. However the quantity of rum which can enter France under such favourable conditions is strictly limited and the exports are likely to keep to the present figures for a few years at least.

For many years the only varieties grown were Big Tanna (Yellow Caledonia) in the wetter districts and Ribbon and White Transparent in the dry regions. On all the large estates now, however, B.H. 10 (12) and S.C. 12 (4) are being planted on a large scale and they are having the desired effect on field and factory returns. G. 119 is being rapidly extended and planters claim that it gives very heavy tonnages.

As in Trinidad and Barbados, and unlike the Porto Rican practice, farmyard manure is made up and used. On some estates the trash is buried (cane is not burned previous to cutting).

One large concern obtained 34 tons per acre from plant canes this year, 19 tons from first ratoons and 15 tons from older ratoons. One field of G. 119 plants gave 54 tons per acre. They are hoping to do better when all the Big Tanna has been replaced by B.H. 10 (12), S.C. 12 (4) and G. 119. The manures used here are 890 lbs. nitrate of Soda (in two doses), 176 lbs. superphosphate and 176 lbs. potassium chloride. One of these factories was run last grinding for fifteen days on B.H. 10 (12) alone. The rendiment was 2.6% higher than with Big Tanna. A crystallizer-pan recently installed in this factory is reported not to be doing all that was expected of it.

The following estimates of the cost of various operations were circulated by one large central to its staff this year:

First ploughing by rented animals	\$4.40	per acre
Second ditto	4.00	
Furrowing	2.40	
Applying 8 cwt. basic slag per acre	0.29	
Cutting and transport of plants and planting	4.40	
Farmyard manuring	2.40	
Interrow cultivation and cleaning of drains	0.40	
Manuring plants (720 lbs. mixed fertilizer, buried)	0.80	
„ ratoons „ „ „ „	0.96	
Weeding young plants before farmyard manuring	1.60—1.92	
„ „ „ after „ „	1.20—1.60	
„ plant canes	2.40	
„ ratoons	2.80—3.20	

The weeders are expected to bring the weeds out of the field,

An interesting development in this Colony has been the gradual building up of a small but flourishing banana industry. In 1921 the banana exports amounted to about 1,200 lb. valued at $14. By 1930 they had gradually risen to 2,278 tons, valued at $135,000. For the first five months of this year the exports were :—

By French mail steamers	27,250	bunches
„ „ cargo „	26,200	„
„ foreign „	22,295	„
	75,745	„

Martinique too is becoming interested and its banana exports have risen from 9 tons in 1926 to almost 1,000 tons in 1930.

Much remains to be done in providing better facilities locally (the bunch bought for 25 cents from the planter costs nearly $2.00 when crated and put on board) and above all in obtaining more frequent shipping opportunities and more room on the ships, but experience is being gained and there is every prospect of a greater development.

During my stay in Guadeloupe, I was asked for information about Demerara Rice. It appears that a considerable trade in this commodity existed some years ago, but it is said that the market was spoiled by frequent shipments of evil-smelling rice. Be that as it may, I was informed that the moment is now opportune for a re-opening of the trade. Guadeloupe has a population of 230,000 and Martinique 203,000. Rice is an important item in the diet of these people, and the two islands form a potential market for Demerara Rice which should not be despised.

BARBADOS.

I was afforded splendid opportunities of seeing the mass breeding of moth borer parasites, the breeding equipment and plots at the Central Experimental Station at Codrington and at Lion Castle, varietal, spacing and other experiments at numerous points in the island and the greater part of the commercial cultivation, while it was my privilege too to discuss methods, problems, etc., with officers who are doing work there which is similar or kindred to my own. Estate cultural methods, etc., are very different from those which prevail or can prevail here, but the fundamental scientific research on cane breeding and culture which is being executed by the Barbados Department of Agriculture, is of great importance to that Colony, this West Indian region and the Sugar Industry of the World. I can hardly over estimate the value of this opportunity to make myself thoroughly familiar with the work.

The following varieties have been introduced here from Barbados :

B. 891	Co. 281
755	P.O.J. 2364
726	

It is interesting to note that Barbados only imports varieties which have passed through the rigorous quarantine imposed by the U. S. Government at Washington.

In the breeding work the Java strain is now being introduced. Selection is being carried on simultaneously for an early, medium and late maturing cane, the idea being that eventually each district can have three varieties which, planted and reaped at the right time, will yield high sucrose and purity throughout the grinding season.

The selection is very rigorous from the sucrose standpoint and canes that are not as sweet as B.H, 10 (12) are given little or no consideration.

Barbados has put up a determined fight against mosaic and by dint of constant inspections and rogueing, careful selection and distribution of healthy seed (enforced by law) the disease appears to be now well under control and causing little appreciable damage. But it is not eradicated and there should be no relaxing in the measures taken.

Gummosis appears to have spread since I first pointed out its leaf symptoms to one of the Agricultural officers in May 1929. It was then so obscure that it had passed unnoticed. Indeed its presence was at first denied, but a couple of months later my supicions were confirmed and now the leaf symtoms of the disease are to be seen over large areas in fields of Ba 11569. It is hoped to meet the situation by developing a resistant cane with the commercial qualities of Ba.11569.

The varieties most grown in Barbados are B.H. 10 (12) in wetter districts and Ba. 11569 in the drier sections. However several hundred acres of B. 726, a new cane, will be reaped next grinding, and a smaller area of B. 891, another new cane.

COVER CROPS AND GREEN MANURES.

BY

E. M. PETERKIN,

Agricultural Superintendent, Department of Agriculture, British Guiana

AND

H. D. HUGGINS, Dip. Agr. (I.C.T.A.),

Asst. Agricultural Superintendent, Department of Agriculture, British Guiana.

One of the most noticeable features in local systems of agriculture is the complete absence of either green manure or cover crops in any of the routines practised. The encouraging results which have recently been obtained with trials with these crops at the Department's stations have caused it to appear desirable to the writers to draw attention to the possibilities for the more general and extensive locally use of these crops.

In this article the utility of cover crops is more stressed than that of green manures since local peasant agricultural practices make little provision for the incorporation of large amounts of organic matter in the soil, and until mechanical means can and are more generally employed by the farmer, the use of green manure crops seems unlikely.

The functions of green manures and cover crops are not similar although these functions are frequently performed by the same plant. A cover crop is planted in order to cover and protect the soil ; a green manure crop is grown and at some period of its growth is cut and incorporated with the soil in order to increase the organic matter content of the soil and to convert plant food in the soil into a more readily available form. A crop having been sown as a cover may be later ploughed in and thereby additionally serve as a green manure—and this is a common practice ; frequently however, a green manure crop is grown solely for the purpose of improving soil fertility and no consideration is given to the question of shade, in some cases the green manure not even being grown *in situ.*

The chief points of consideration in connexion with cover crops are :—

(1) The control of moisture in the soil. A very generally accepted opinion is that cover crops conserve moisture by preventing evaporation from the soil surface and are thereby of great utility especially in dry situations.

Buntung and Milsum[1] consider this view erroneous and that the idea may have originated from the fact that the surface of the soil, beneath a low growing crop, is always moist owing to the fact that the cover plant prevents the drying of the surface layer of soil by evaporation. This condition is, however, considered

[1] BUNTUNG and MILSUM, J.N., *Malayan Agr. Jour.*, Vol. XVI, No. 7,

to be artificial since "it is well recognised by scientific workers that a leafy crop is capable of evaporating three or four times as much water as the bare surface of soil on land lying under fallow." Nevertheless the results of experiments[1] carried out at the Government Experimental Plantation, Serdang, in Malaya, indicate that it is improbable that cover crops exercise any harmful effects *on the score of reduction of soil moisture content* even of young crops.

The question of the effect of cover crops on soil moisture control in British Guiana is important, for although the annual rainfall in this Colony is high the dry seasons are, in most years, well marked: were it demonstrated that the presence of a cover tended to enhance the drying out of the soil this might, with reason, be considered a powerful deterrent to the more general local use of these crops.

(2) The effect on weed control. The growing of a crop which gives a quick, dense, low cover is one of the cheapest and most efficient methods of weed control practised. All classes of weeds are more or less susceptible to the effects of a crop which grows quickly enough and vigorously enough to act as a "smother crop" and this is perhaps one of the phases of cover crop effect most deserving of local attention.

In peasant agriculture, there is usually great activity when the early rains come; weeding and forking are done and vegetable crops planted. Such farms usually, during the preceding dry season, have had little cultural attention and not infrequently have been covered with a thick growth of grass and other weeds. The lack of control of these weeds—the germination of the seed and the "catching" of the root stocks of which are encouraged by the rains—is a factor having very profound effects on local peasant cultivation; for this reason *inter alia* the culture of none but hardy crops (e.g., plantains, cassava, yams) is successfully pursued. Weed control is, the writers are convinced, one of the most important factors to be considered in local peasant agricultural economics.

Of the covers tried at the Department's Experiment Stations, Bengal Beans give most promise in connexion with weed control in unoccupied areas. *Canavlia* is also very satisfactory in this respect but is not as easily established in unprepared lands as Bengal Beans.

(3) In undulating and hilly countries one of the most important advantages derived from the use of cover crops is the protection of the soil from surface wash. Although most of the cultivated areas in this Colony are comparatively level yet on account of the high local precipitation and the torrential downpours which occur regularly in the wet seasons, soil wash is also a problem worthy of local consideration.

(4) The use of cover crops in land that is being rested. Instead of such land being taken over by weeds with the ensuing difficulties of reclamation, unoccupied land, under covers, would in addition to being enriched in plant food be comparatively easily "taken in."

[1]BELGRAVE, W.N.C., *Malayan Agr. Jour.*, Vol. XVIII, No. 10, p. 494.

Other uses of cover crops are that the soil is improved both because the soil is aerated, as the roots of the cover tend to penetrate and open the soil, and because the crop absorbs and retains plant food that may otherwise be washed away, that a dense cover protects the soil from the sun's rays and from over-heating, that the leaves and stems fall and decay and increase the organic matter in the soil, and that nitrogen from the atmosphere may be fixed if the cover is a leguminous one.

A green manure crop frequently possesses all of the above-mentioned advantages and in addition may give from two to ten tons of green material per acre. The incorporation of this material with the soil greatly increases the organic matter content of the soil and on the heavy coastal soils of the Colony the physical effect on the soil is feasibly almost as important as the manurial.

SOME OBJECTIONS TO COVER CROPS.

1. Many of the favoured covers have a tendency to twine and will in consequence climb on the main crop whose growth may be considerably impeded. This is the principal objection to Bengal Beans.

2. Certain covers from which large amounts of dry material fall may increase the chances of fire.

3. It is claimed that the main crop sometimes makes slower progress when grown with covers than if the land is clean weeded.

4. In the case of coconuts the coconut beetle may be encouraged when an excessive quantity of organic matter accumulates. In addition unless the cover be low growing the difficulties of nut collection are increased.

5. Marsh[1] states that the faster spread of root disease under cover crops has been noticed both on rubber and coffee estates.

SELECTION OF A COVER.

The work with cover plants carried out by this Department has been planned largely with a view to observing the rate and manner of growth and vigour under local conditions necessary for these crops to become established, the period taken from planting to maturity and the ability or otherwise of these crops to keep themselves established once they have been planted. It is essential that this information be gained since experience has shown that a cover which may give good results in one locality may be disappointing under different conditions (e.g., rainfall, type of soil, etc.) and a cover which may be suitable for one plantation crop may be unsuitable for another. Thus Sampson[2] reports that *Centrosema pubescens* Benth. gave good results as a cover for native rubber in the Cochin rubber districts of S. India while this cover was found to be unsuitable for mature rubber in Malaya, where, however, it gave good results under coconuts.

[1] MARSH, T. D., *Trop. Agricst.*, Vol. LXIV, No. 3, 1925, p. 156.
[2] SAMPSON, H, C. *Trop. Agricst.*, Vol. LXXI, No. 3.

In general, the important considerations in the selection of a cover crop are:—

(a) Plants should make rapid growth in order to cover the ground quickly.

(b) A leguminous plant is to be preferred.

(c) A perennial plant on account of its permanency is preferable unless the plant be one such as Bengal Bean which continually re-seeds itself.

(d) A plant which creeps usually supplies a more effective cover.

(e) Plants which flourish best in the open should be selected for young crops and plants which are tolerant to shade should be chosen for established crops.

(f) The cover should not be susceptible to either pests or diseases which attack the main crop.

(g) Plants which grow easily from seed and which develop a good root system (thereby helping to bind the surface soil) are recommended.

Bengal Bean (*Stizolobium* spp.)

There are three species under cultivation, *S. atterimum* (black seeded), *S. niveum* (white seeded) and *S. deeringianum* (grey seeded). *Atterimum* grew on the Experiment Station for twelve months and, as soon as the rains began, the plot reseeded itself and again became established; *niveum* and *deeringianum* died down entirely within five months.

Of the covers tried, Bengal Beans appear to be the best cover for thrown out land, as its climbing habit does not become inconvenient in such areas but is rather an advantage for controlling quick growing and up-standing weeds. This cover has been found to establish itself successfully even in unweeded land.

Sword Bean (*Canavalia spp.*)

Two varieties, *C. ensiformis* (white seeded) and *C. gladiata* (pink seeded) are under trial. Both of these varieties have been established for approximately 16 months and are now showing signs of dying down. These are being left for observation. *Canavalia* does not climb, is more erect in habit and does not become established as a cover as quickly as Bengal Beans. Once established, the cover is one of the most efficient obtained locally, but the indications are that the trouble and expense of establishing *Canavalia* in unprepared land are considerably greater than in the case of Bengal Beans.

Although *Canavalia* does not climb, the height to which it grows renders it unsuitable for use as a cover under any of the main crops grown locally. This cover, therefore, like Bengal Beans, should be used in unoccupied land. The large amount of vegetable matter, produced both by this crop and Bengal

Photo by *C. Headecker*
A cover produced by Bush Bonavist—a plot at the Department's Experiment Station.

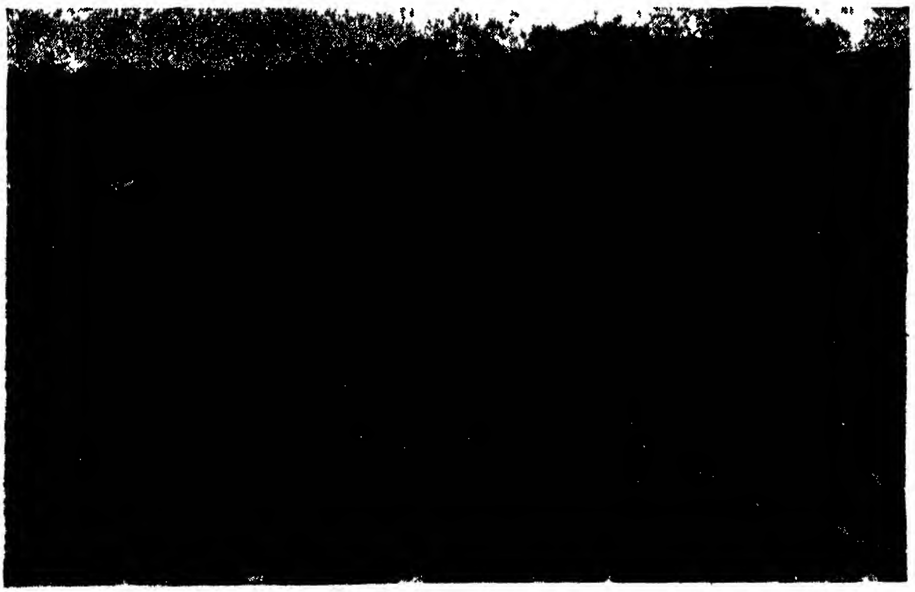


Photo by *C Headecker*
A cover produced by Black Eye Peas—a plot at the Department's Experiment Station.

PLATE XI.

Photo by C. Headecker

A cover produced by Bengal Beans—a plot at the Department's Experiment Station.

Beans, renders them both particularly suitable for incorporating with and reconditioning of worn out land.

Dolichos spp.

There are two varieties, *D. hosei* and *D. lablab*. *D. hosei* is low growing, forming a regular carpet, is a weak climber and extremely shy seeder, and usually has to be propagated by root and stem cuttings. A plot of this cover was planted from such cuttings (obtained from Trinidad) about 12 months ago, and there is no indication at present that the crop will in the near future die off. *Hosei* promises to be one of the most attractive and efficient covers for permanent crops, such as citrus and coconuts. On account of the low habit, this should be especially suitable for growth under the latter crop, since the nuts would not become hidden and the costs of collection thereby increased. It has however been observed locally that this species sometimes establishes itself very slowly.

Bush Bonavist, a variety of *D. lablab*, does not climb, grows to a height of about 3 ft. and the duration period is about 9 months. This is a food crop as well as an efficient cover and is especially suitable for interplanting with plantains and bananas. On account of its food-yielding qualities this cover should recommend itself to the local farmer. *D. lablab* is also a fair cover, but trials with this indicate that the above-mentioned species of *Dolichos* are preferable.

Centrosema pubescens.

This cover does not appear to be as low growing as *D. hosei* but is also a very efficient cover. *Centrosema* seeds freely and is easily propagated by seed. A plot has been grown for approximately 12 months and still appears to be growing vigorously. This should also make satisfactory cover for permanent crops.

Crotalaria spp.

There are various species of Crotalaria under observation, but *C. striata*, *C. juncea*, and *C. usaramoensis* give most promise and, of these, the first mentioned is preferred. Although *striata* is not low growing, the cover afforded is efficient and if the seed is broadcast in land that has been lightly weeded, striata will establish itself as a cover in about eight weeks.

Black Eye Peas.

The following are the conclusions drawn[1] from the results of trials carried out with this crop at Onderneeming and the trials at the Department's Stations have since confirmed these recommendations :—

(1) Black Eye Peas can be interplanted between many other crop plants and so there is no additional cost in the prepartion of the land.

[1] Huggins, H. D., *Agr. Jour. of Br. Guiana*, Vol. II, No. 2, p. 115.

(2) If the peas are grown thickly enough, as advised, a quicky growing and efficient cover crop is obtained. This keeps down weeds, and helps to keep the soil at an even temperature.

(3) A product, always readily saleable, can be obtained in eight to twelve weeks. The local price for these peas varies from five to twelve cents per pound.

(4) A comparatively non-perishable product is obtained, and, if and when necessary, better prices may be waited for.

(5) The market is never glutted, and there are, at present, large quantities of these peas imported into the Colony.

THE PROGRESS AND POSSIBILITIES OF PURE BRED POULTRY IN BRITISH GUIANA

BY

JOHN FERNANDES,

Hon. Sec. B.G. Poultry Association.

After several attempts, extending over a number of years, pure bred poultry of various breeds is slowly but surely replacing Mongrels throughout the Colony. Breeding stock has been shipped to nearly every part of the Colony from the North West District at one end to the Corentyne coast at the other, and to the Hinterland as far as the Rupununi. Pure bred poultry as we know it to-day is far different from what it was ten years ago. It is being recognised that pure bred birds are equally as hardy as mongrels and lay twice as many eggs under the same conditions, if they have been bred from good vigorous egg-laying ancestors. During this year this has been established beyond a doubt.

The Government Stock Farm raised quite a number of chicks under exceedingly difficult conditions and very bad weather. The writer followed their example and allowed his growing stock to be out during the entire rainy season; as in both cases the soil was heavy clay it was really a test of vitality. The birds were fairly well advanced and fully feathered before the rains and so were well able to stand it. That there was very low mortality is attributed to proper housing, proper feeding and, last but not least, good breeding stock.

White Leghorns, looked upon by many as being the most difficult of all breeds to raise here, were well represented in both flocks; at the Government Stock Farm there were about 60% White Leghorns while in my own it was just about 20%.

There were perhaps more pure bred chickens raised this year in the Colony than during any five years previously. This was mainly on account of the forming of the British Guiana Poultry Association in October of last year whose members, besides instilling interest in pure bred poultry by introducing various new and up-to-date methods for breeding chicks and by raising them successfully, imported no less than 157 birds of various breeds. These, along with 14 birds imported by the Government Stock Farm, added to the breeding stock already in the Colony, were still insufficient to meet the demand for hatching eggs—the Government Stock Farm particularly being very heavily over-booked. This will give an idea of the increased interest.

The British Guiana Poultry Association is holding its First Annual Poultry Show on 3rd October in the Promenade Gardens. This will most assuredly

stimulate more interest in pure bred stock. Included in this Show will be a demonstration farm showing the various stages of chicken life from egg shell to breeding pen—all on modern lines. This should be very interesting from an educational standpoint.

There is plenty of room for improvement as at present both the local table birds and egg supply are of very poor quality. If we succeed in raising our quality in both of these to that demanded in the larger up-to-date cities then we can consider that we have done well. To do this we shall have to improve our stock.

Several Ways of Improving the Flock.

Mongrels can be graded up by the use of pure bred males. Select some of your best layers from your mongrel flock, buy a cockerel to mate with them from a recognised breeder, be sure that you get a good one; if the object is to breed for eggs alone use a White Leghorn, and if for eggs and meat use either the Plymouth Rock, Rhode Island Red or Wyandotte. The pullets of this mating can be either mated back to their sire or to a new unrelated cockerel of the breed originally used. The offspring of the first mating will be half-bred and of the second mating three-quarter bred and from this grade upwards would begin to get more uniform in colour, shape, etc. If this mating is kept up over a period of years the birds, with very few exceptions, would look exactly like Pure Breds, but should never be sold as such as there is always a likelihood of a throw back. This method of grading up is recommended to those who still hold on to the idea that half-bred birds are hardier than those that are pure bred. It is recommended to make a start either with hatching eggs or a mated pen ready for breeding.

Starting With Hatching Eggs.

Buy hatching eggs from a reliable source, selecting the breed that suits your purpose best. Set them under your best broody hens available. If the eggs are from good hardy stock you should obtain a hatch of at least 75% and the chicks should be strong and vigorous. With a little care 90% of the chicks hatched can be reared. A good start can thus be got with Pure Bred stock at a very small cost.

A Faster Way.

For those who do not want to wait until their chicks grow up they can buy a ready mated breeding pen. It is really surprising to see how many chicks can be raised out of a single breeding pen of six females and one male in one year. The Government Stock Farm received their pen of White Leghorns in September, 1930, and never sold eggs for hatching or used any for this purpose until some time in December, and at present there are well over two hundred young birds bred out of this pen in the Colony to-day. The writer has also been very successful with a pen of Barred Plymouth Rocks (six females and one male)

which arrived here late in November, and has raised over 150 birds from this pen besides selling quite a number of hatching eggs.

Ready mated pens of course are not very cheap if they come from good stock, but this is a case of the best being the cheapest in the long run. Poor layers eat the same quantity of feed and require the same housing accommodation as good layers, but will nearly always lose money for their owners while good layers will make money. So always try and get a good start. Several breeders sell part-grown stock which is perhaps easier for beginners than raising chickens and this saves a little time, but sooner or later one has to learn to raise chicks successfully in order to succeed with poultry.

WHICH IS THE BEST BREED FOR BRITISH GUIANA.

This is a question often asked but not easily answered since all of the better known breeds do well when handled properly. Each breed has to be handled differently, and this is the reason why it is difficult to run pullets of different breeds together successfully. The egg breeds are to be fed differently from the dual purpose breeds and the purely meat breeds are to be fed still in another way. Sometimes two strains of the same breed have to be fed and handled differently in order to get best results.

THE BARRED PLYMOUTH ROCK—A FAVOURITE.

The Barred Plymouth Rock has been the writer's favourite from the very beginning and he has always been successful with them, though like all other breeds they need careful handling. They are good layers, ideal table birds and as hardy as any of the other breeds. However if we are ever to hope for an export trade in eggs it is to the White Leghorn that we will have to look.

THE WHITE LEGHORN.

The White Leghorn is often called the "egg machine". It consumes less feed than the heavier birds and usually lays more eggs, though both the Australorp and the Barred Plymouth Rock are higher up in the world's records for individual birds. White Leghorns have been bred for quantity and size of eggs perhaps longer than any other breed known, so it should be easier to get a high egg average with this breed than any other.

THE POSSIBILITY OF AN EXPORT TRADE IN EGGS.

There is a possibility of eggs being exported from this colony but the time is very far off. We shall first have to supply our local demand. If eggs and meat of a better grade were produced here, the local demand would be much greater than it is at present. Good standard eggs can be produced locally to be sold at one shilling a dozen and yield a reasonably good profit. Table poultry may not be produced at a price that will enable farmers to sell it as cheap as it is at present, *viz.*:—16 cents per lb., but the quality

will be so much better that it would be really worth twice as much. If every mongrel hen in the colony were replaced by pure bred hens, bred for egg production, there would be sufficient eggs to supply an increased demand locally and still have a surplus to be exported. Whether or not an export market can be found for any surplus eggs does not matter since the time for this is still very far off and can be forgotten for the present.

At present 75% of the breeders of pure bred poultry use imported feeds. The writer has also been using these but, on account of the high price, is now experimenting with local feed mixtures. It is very difficult to get a supply of properly dried corn throughout the year, but this difficulty can be overcome by buying large stocks in season and storing it. Then there is the difficulty of obtaining liquid skimmed milk, and as there is no creamery here it is practically unobtainable. On account of the prohibitive duty, skimmed milk powder cannot be imported. It is going to be very difficult to find a local mixture to raise chicks successfully without skimmed milk. For growing, breeding and laying stock it is much easier and it is certain that after experimenting we shall find a formula that will meet our needs and still be very cheap.

The birds on the Government Stock Farm are reared on local mixtures, but they have milk to help them balance their food ; very few poultry owners are placed in similar positions. If a creamery is established here it will solve nearly all our feed difficulties.

Great care should be taken in feeding the flock as nothing puts birds off faster than bad feeding or bad foods. Birds should be weighed occasionally to see whether they are losing or gaining weight and fed accordingly. Birds need less heat-giving food in our tropical climate than in the colder countries.

Selection of Eggs for Hatching, Broody Hens and Nests.

Eggs for hatching should be normal in size and shape and as near the same shape as possible. Discard all mis-shaped eggs as they indicate an abnormal condition on the part of the hen that laid them and such eggs are rarely hatchable. Eggs should be kept as cool as possible and certainly not exposed to the rays of the sun. They should be laid on their sides and turned daily. Do not keep them longer than seven to ten days before setting.

Just because a hen becomes broody it does not mean that she should be used for hatching purposes. It depends on the individual, as some hens are noted for their fickleness. They may think they want to sit to-day and change their minds to-morrow and spoil all the eggs given them. None but strong, healthy hens should be allowed to sit. Be sure that the hen is really broody by trying her with a few artificial eggs and see if she keeps the nest then you can replace the artificial by good eggs.

Preparation of the Nests.

Obtain a box 18 inches square. Use the lid to make a sliding door which can be moved up or down. Cut out one side of the box because a floor will not be required. Make ventilation holes in the top, back and sides of the box. Choose a cool shady spot away from the other birds for the broody hens to sit. Dig up the soil at this spot and then moisten it with a solution of some disinfectant. Make a slight hollow in the prepared ground and use dry grass to form a nest in the hollow, then place the box over the nest. Dust the nest as well as the hen before sitting so as to avoid lice and nimbles as this makes the hen more comfortable and quiet.

Number of Eggs to Sit.

A common fault is to try to have the hen cover too many eggs. An average mongrel hen can cov er 12 eggs, but if given nine or ten she will bring them out closer together and the chicks will be stronger. If the above directions are followed carefully and a good hatch not obtained then the fault is with the eggs.

Artificial Brooding.

Chicks may be brooded artificially. The following system has been tried by quite a few people successfully :—

Sit two or more hens at the same time, take away the chicks from the hen as soon as they are properly dried after hatching. Get a small box and place the chicks inside, put a piece of flannel over the top and allow it to sag so that it touches the back of the chicks. Take the chicks out of the box for their first feed 36 to 48 hours after they are hatched. Feed, on starting, mash—allowing chicks to eat for ten minutes at a time three or four times per day for the first two days. Give them clean water to drink and a small bit of clean sand as grit. After the second day put them in a wire floored brooder. Keep the starting mash before them all the time along with clean water; grit and greens should also be given regularly. Put them at night in the flannel covered box gradually removing the flannel until it is taken away altogether. The chicks can then be kept in the wire floored brooder day and night and should give very little trouble after this.

The wire floor allows all droppings to pass through and therefore keeps the chicks clean and away from their own droppings.

Chick Diseases.

The most serious chick diseases are Roup and Chicken Pox. These take a heavy toll of chicks of all ages. Sometimes an entire flock of chicks is wiped out by them. The best way to evade the ravages of these diseases is to take strong preventive measures.

Keep everything about the chicken house and runs well disinfected and as clean as possible, keep them free from lice and mites and in general good condition taking care to destroy all weaklings as you go along.

An easy way to tell when chicks are going off-colour is to examine their crops at night. Those that are doing well will have full crops and those with the slightest trouble will usually have only half-filled or empty crops. As soon as this is discovered put a small bit of Epsom Salts in the drinking water occasionally and this will in most cases put them right again. At twelve weeks old separate the cockerels from the pullets and grow them separately. Continue to cull them all the time. As soon as the slightest defect is seen throw out the particular bird immediately so that when the pullets go into laying quarters they will be a selected lot and should lay well.

REPORT ON A SHORT VISIT TO TRINIDAD IN CONNECTION WITH CITRUS CULTURE

BY

EDGAR BECKETT, F.L.S.,
Agricultural Superintendent, North West District.

On account of the progress made in connection with the citrus industry in Trinidad, it was decided that the writer, on his way back from leave, should stop at Trinidad and make himself acquainted with the work being done in Trinidad.

The most important places visited were—Hon. G. F. Huggins' Citrus Estate at Macqueripe; Mr. G. Lee's Lime Factory, Carenage; the St. Augustine Experiment Station on several occasions, where I had the pleasure of meeting Mr. Buthn whose help and information on the technique of budding and grafting was most interesting and helpful; Santa Cecilia, a property recently acquired by Dr. Murray of San Fernando; the Co-operative Packing House of the Co-operative Citrus Growers' Association: Mr. S. Fitt's grapefruit cultivation at Santa Cruz Valley; "St. Charles," Cunupia and Santa Cruz, properties of Mr. A. V. Stollmeyer; River Estate and the Imperial College of Tropical Agriculture, where Professor G. E. Cheesman and Mr. P. E. Turner did all in their power to make the visit of value to me.

Grapefruit.—On the recommendation of Professor Clark Powell, Mr. R. O. Williams the then Superintendent of the Royal Botanic Gardens and Assistant Botanist, was sent by the Government of Trinidad to Florida and Porto Rico for three months in 1929 to study the conditions under which grapefruit are grown and "handled" from nursery treatment to the shipping of the fruit.

It is of interest to note that Mr. Williams when at Washington (having broken his journey to Florida at Washington) was assured by Mr. K. A. Ryerson, Senior Horticulturist-in-Charge of the Plant and Seed Introduction Work, as well as by all other scientists with whom he discussed the matter, that there was no risk of introducing citrus canker to Trinidad by taking plants from Florida, and the famous Glen St. Mary Nursery at Winter Haven was recommended, if any citrus plants were required. I may mention that one of our farmers in the North West District has already imported a few citrus from these nurseries and the plants have made a good start on his lands in the Arukamai.

On his return to Trinidad with the knowledge gained from this visit, the development of the grapefruit industry is now a practical proposition. Already a co-operative Citrus Growers' Association has been formed in Trinidad, a packing house 140′ x 60′ has been built under the supervision of Mr. A. V. Stollmeyer

of which the Association should be proud, whilst an expert from Florida and the necessary and most up-to-date machinery will soon be on the spot.

All growers appear to be furnished with field boxes, packing boxes, and in short nothing seems to have been overlooked, from the importation of the tuttle clipper and picking bags to the necessary machinery for washing, cleaning and polishing.

An Ordinance, known as the "Exportation of Fruit Ordinance, 1931," has been passed, which it is intended to bring into operation in December, 1931. All fruit intended for export from the Trinidad Colony has to be packed and shipped in accordance with the regulations laid down. The Officer-in-Charge of the Packing House has to give written notice to the Chief Fruit Inspector of the time during which it is proposed to pack fruit, and no fruit can be wrapped or packed until is has been inspected and approved by a Fruit Inspector, including inspection of containers. All the fruit intended for export has to be graded for quality, the grades laid down being :—

1. Fancy.
2. Choice.
3. Bronze.
4. Standard.
5. Russet.

The crates have to be of the Florida pattern with panel ends and centre pieces with inside dimensions of 12″ x 12″ x 24″ and the fruit must be so packed that the cover will bulge at the middle, provided that the overall height of the box after packing does not exceed 14½ inches. A flat pack can only be used to meet the requirements of any special trade or special order, and then it must be to the satisfaction of the Fruit Inspector. The cover must be fastened over the centre by a metal strap, not less than 18 inches in length and an additional strap or wire fastened completely around the base at each end for all crates for export. An attractive label representing the brand must be pasted on each end panel. The number of fruit in the box must be stamped on the top left hand corner, and the variety on the right hand corner The fruit has to be uniformily sized (apart from grading) to represent the following numbers per crate :—

28	64	100	200
36	70	126	216
46	80	150	250
54	96	176	324

Each fruit must be tightly wrapped in good paper which bears a design representing the brand of fruit, all such designs must face the outsides of the box.

No person is to attempt to, or to export fruit unless the Ordinance and Regulations are complied with, for non-observance one is liable to a penalty of £25. It will thus be seen that, at the present moment, Trinidad has everything

in train for the successful development of the citrus industry and grapefruit industry in particular.

Nursery Work:—At the time of this visit, the Experiment Station was being transferred from St. Clair to St. Augustine but one was able to note the stock and the methods of budding and grafting. As with us in British Guiana, the Porto Rican method of removing plants with a ball of soil and little, if any reduction of the head, proves more satisfactory than the method practised in Florida, where the tree is pruned to a straight stump.

Stocks:—A large number of stocks is to be seen already at the new Experiment Station consisting of sour orange, "wild" grapefruit, rough lemon, etc. Though the sour orange appears to be suitable for grapefruit on light soils especially, nevertheless experiments are being undertaken with rough lemon and "wild" grapefruit stocks. "Wild" grapefruit seems to have much to recommend it for stock purposes.

Investigations of stock other than sour orange are certainly necessary but it will take a number of years before evidence can be forthcoming as to suitability of various stocks. At present it would appear that for grapefruit commercial plantings the sour orange root stock should be utilized. No small or badly grown or backward stocks are utilized, all such should be destroyed at the time of budding.

Apparently there is a large demand on the nurseries for budded grapefruit though some Trinidad planters raise their own stocks and carry on their own budding.

Plantings:—The various cultivations I inspected were full of interest. One area of an acre each planted by the Department of Agriculture in August, 1923, of Grapefruit (Walters, Marsh, Foster and Duncan) and four varieties of oranges (Washington Navel, Jaffa, Parson Brown and Tardiff Hart Late) was in splendid condition. The trees had been spaced 25′ x 25′ and budded on sour orange. Cropping commenced in 1926, the fourth year from planting. All made excellent growth except the Navel Orange and from the figures shown me it was a commercial success.

All the citrus cultivations visited were, with perhaps one exception, in excellent condition. It was obvious that grapefruit should not be spaced closer than 30′ x 30′ whilst the importance of correct planting was very noticeable. It was borne out too, that planting with a ball of earth was apparently better than the bare root method practised in Florida. Some of the grapefruit groves inspected were a dark living green of perfect health and laden with young fruit. I especially admired one cultivation of young trees in the Cunupia District which had made remarkably fine growth. Here the grove was kept entirely free from weeds and a crop of peanuts and sweet potatoes had been interplanted—the whole area presenting a pleasing picture of living green, full of promise for the future.

The ill effect of deep planting was plainly to be seen in one property inspected. Deep planting is one of the causes of gummosis. In correct planting the crown roots can just be seen.

Cultural Treatment. It was obvious that to get the best results, rank weeds and grasses cannot be allowed to grow in a citrus cultivation, though a perfectly clean cultivation without some cover crop would probably be disastrous, owing to the loss of organic matter and the leaching effect of rain. Cultural operations should aim at getting a fine tilth and the planting of a suitable cover crop. Circles around the trees for at least three feet from the branches kept in a state of good tilth with careful mulching, might be sufficient where it is impossible to dig out all weeds and rough grasses throughout the whole area, whilst these might gradually be eliminated by means of a sturdy cover crop, such as *Crotalaria striata*. Great care has to be taken that the stems of trees are not injured in any way by field workers. So far as British Guiana is concerned I am of opinion that careful mulching operations are of the utmost importance to citrus growers.

Artificial Colouring of Grapefruit. According to Mr. Williams' figures the Florida monthly farm price of grapefruit from 1918-1928 was as follows:

Month.	*Dollars per crate.*
October	$ 1.89
November	1.84
December	1.83
January	1.81
February	1.78
March	1.94
April	2.05
May	2.37

and he points out that in Trinidad the crop is later, late December or early January, with the fruit usually in better condition from February to May. Grapefruit then in Trinidad can be allowed to remain on the trees (especially "Marsh" which has few, if any, seeds and consequently less chance of drying) to ripen and allow Nature to give the fruit the bright yellow colouring often gained by artificial means. Hence the expense of artificial colouring does not come in with grapefruit so far as Trinidad is concerned, as the crop ripens too late for an early market.

Fertilizers. Apart from cultural methods the question of fertilizers will doubtless have to be considered and experiments in this connection will probably be necessary. Mr. Williams is of the opinion that as the trees get older, unless fertilizers are applied, the fruit will run out into small sizes. In this connection I may quote Professor Clark Powell:—

> "Mulching alone may prove to be insufficient over a long period of "time and it certainly cannot be used to the exclusion of everything else

"on poor soils. It is quite possible that it will be found advisable to "supplement mulching with the use of manure or commercial fertilizers, "but information on this point will not be forthcoming for some years.

"Commercial fertilizers should not be used unless the planter is "satisfied that their use is necessary. Statements of fertilizer dealers "should not form the basis for the fertilizer practice to be adopted, nor "should consideration be given to soil analyses. If the trees are healthy "and vigorous and bearing well, they are in no immediate need of "fertilizers. If the annual growth is unsatisfactory, if production declines "or if the foliage becomes pale in colour, fertilization may be the solu- "tion of the trouble. Before acting on the conclusion, however, the "planter should explore other factors such as insect injury or disease and "particularly drainage. Water-logging of the soil is highly injurious "and may readily occur under conditions of heavy rainfall. Fertilizers "are expensive and should only be used as a last resort.

"One frequently hears of the injurious results in Florida occurring "when manure is used in the citrus groves. Planters in the West Indies "should not assume that injurious effects will follow their use of manure. "Because of the sandy nature of the soils of Florida, the nitrogen in the "manure becomes available very rapidly and probably results in over "stimulation of the trees. Manure added to the heavier West Indian "soils would not react in the same way.

Windbreaks. It is obvious that windbreaks are a necessity under certain conditions where citrus groves are established.

Limes. Two lime factories were visited and the lime fruit at the various centres inspected.

For the green lime trade the market appears to prefer the small West Indian lime and not the large lime fruit so frequently seen in lime groves in British Guiana. It would appear that the green lime trade will have to be considered by our growers inasmuch as concentrated juice had dropped at the time I was in the Island to £4 per pipe. Indeed one lime factory informed me that concentrated juice, he had been informed by his London agent, was unsaleable and he had been directed to make citrate of lime and at the time of my visit he was busy getting a centrifugal in order as a necessary adjunct to drying.

Mr. R. O. Williams has done work which was of great interest to me in breeding a lime hybrid which is immune to Wither Tip (*Glaeosporium limetticolum*) but as he has not yet finished his experiments I can only just refer to this.

There was one point worthy of notice in the Co-operative Lime Factory and that was that the containers for distilled oil of limes which were being utilised are much cheaper than those in use in this Colony—the makers are "The Arthur Schwartz Corporation" of 52, Harrison Street, New York". This corporation has also been making enquiries about green limes.

The Imperial College of Tropical Agriculture. Much of interest was everything to be seen at the Imperial College. The banana research experiments and the propagation of citrus by means of the solar propagator perhaps were of the greatest importance to me. The following citrus species have already been rooted successfully in the propagator—West Indian lime, Kusai lime, Rangpur lime, T. I. Hybrid lime, Citron and Sour Orange. The modern cold storage building was also of great interest.

General. There is necessity for further research work being done in relation to the influence of stock on scion. It is already known that root stocks influence not only the productivity of the scion but also the time of fruiting and the size of the tree—hence the importance of vegetative propagation when very rapid rooting can be obtained at a relatively small cost with uniformity of plants. Experience has, however, proved that the sour orange stock is very satisfactory for the local conditions. It takes about 15 months from the time a bud is inserted to the time that the plant is ready for the field. In the solar propagator at the College, cuttings of West Indian limes are ready for planting out in a shaded bed in 25 days.

The second point was that Grapefruit can be grown in parts of British Guiana equal to those grown in Trinidad and that in the North West District and elsewhere we grow a lime which compares very favourably in juice, citric acid content and oil. On the other hand, Trinidad has an area of about 1,800 square miles with a population that must be approximately 400,000 souls, and most important of all the Island is furnished with a very excellent road system, hence transport does not assume the alarming proportions as it may do with us in British Guiana. It might be mentioned that one gentleman (Mr. A. V. Stollmeyer) exports mangoes successfully. He has found that so far, only the "Julie" variety is suited for export, and it was very interesting to see the fine specimens of this particular fruit he was preparing for export.

During the inspection of citrus orchards some fine British Honduras Mahogany were noticed. These had been attacked (as are the trees at Hosorora Station) by an insect (*Hypsipyla sp.*) which has so severely attacked trees in the North West District. In spite of these attacks British Honduras Mahogany appears to make extremely rapid growth both in Trinidad and in the North West District of British Guiana. Some very flourishing groves of Teak trees were also observed.

Conclusion. I have to express my thanks for the opportunity of visiting Trinidad and obtaining several hints of importance in connection with the citrus trade. It will be of considerable value for one to see the packing house sometime in January or February 1932, when the machinery and facilities for washing, drying, polishing, sizing, grading, wrapping, packing, etc., are in progress as well as the field operations of picking and transplanting.

I desire to thank Messrs. E. J. Wortley, R. O. Williams, A. V. Stollmeyer, P. E. Turner, F. Buthn and Professor E. E. Cheesman, not only for valuable help given me but also for many kindnesses bestowed.

DISTRICT NOTES.

EAST DEMERARA.

A ten-acre block of pure line Demerara Creole paddy has been established at Pln. Nonpareil for the purpose of supplying seed to selected farmers in the East Coast District. 20 farmers have been established on this area with half an acre each ; this ten-acre block is being grown under the supervision of the District Agricultural Instructor. The seed has been supplied from the Georgetown Station ; the nurseries have been carefully prepared ; and not more than 7 lb. of seed sown to the square rod.

Thanks are due to Mr. E. D. Forte, the Manager, for the great interest he has taken, and help given to make it a success.

Two rice competitions have been started, one on the lower East Coast from Kitty to Mahaica, and one on the upper East Coast, from Mahaica to Abary. In each case three prizes are being given of twenty-five. fifteen and ten dollars. Competitors are only permitted to plant pure line Demerara Creole seed paddy ; seed for this purpose was sold at one cent per pound ; in cases where the competitor satisfied the Instructor that his seed was of sufficient purity he was allowed to plant his own. Every cultural operation is being carefully followed and points given in accordance with the efficiency with which the Department's instructions are being carried out. Three ploughings are being insisted on at regular intervals in order to insure the elimination of volunteer seedlings.

An attempt is being made to start a 4H Club at Beterverwagting Village, under the auspices of the Chairman, Mr. J. R. W. Straughn. A strong Committee has been formed consisting of the village Chairman, the School Managers, head teachers, and the District Commissary; several meetings have been held. A special meeting was held to which all parents were invited with the object of interesting them in the movement ; the Director of Agriculture attended and addressed the parents.

A site has been selected for the garden, which has been ploughed, fenced, drained, and an inlet pipe from the middle-walk canal laid down for irrigation purposes. A great deal of enthusiasm is being displayed which makes one very optimistic for its future success.

At His Excellency's suggestion an area of land at the back of Lodge Village has been given out to farmers, of West Indian descent, with the idea of establishing market gardens to supply Georgetown with fresh vegetables and at the same time to give the unemployed an opportunity to learn something about agriculture,

Its proximity to Georgetown enables them to obtain casual work, and on days when there is no work in town they can work on their allotments. Fifty-eight allotments have been given out of approximately ⅓ of an acre each ; of these fifteen are being worked by ex-service soldiers. An irrigation canal and a drainage trench have been dug on a co-operative basis, *i.e.*, 50% of the cost has been met by Government and 50% has been given in free labour by the settlers. A good start has been made. Eight allotments have had to be taken away from original farmers ; but these have been reissued. Permission has been obtained from the Lamaha Commissioners to put down an intake koker so as to obtain irrigation water from the Lamaha Conservancy for the dry season. The ex-Service men are displaying great zeal.

The usual monthly meetings have been held at the three Co-operative Credit Banks of which I am Chairman, viz. :—Plaisance-Sparendam, Beterverwagting-Triumph, and Buxton-Friendship. Great difficulty has been experienced in collecting outstnding loans ; this may be attributed to the general financial depression. It is expected that conditions will improve by the end of the year.

Sub-Station Cecilia.—This sub-Station has been converted into a demonstration and seed distributing centre for leguminous crops, and is attracting much attention from farmers.

The usual instructional work has been carried on by the District Agricultural Instructor, who besides his ordinary duties has expended much time on *Brassolis* control in the coconut areas.

E. M. PETERKIN,
Agricultural Superintendent,
East Demerara.

WEST DEMERARA.

During the period under review extension duties on the West Coast have been largely concerned with the paddy competitions. The rules governing these competitions were concisely and simply stated in leaflets which were distributed. Blocks of pure line Demerara Creole paddy were established at Windsor Forest and Blankenburg.

Specially selected seed from the Department's seed station, Georgetown, was supplied to each entrant ; precautions were taken and the nurseries were very thoroughly prepared in order to ensure that no 'volunteer' rice germinated ; it was insisted upon that large enough nurseries were made in order that it would be unnecessary to sow seed thicker than 7 lbs. to the square rod.

It was fortunate that more seed, than is normally necessary for the area entered in the competition, was sown in each case, since serious damage was done by ducks this season, in most areas on the coast, to 'bursting' seed.

Each competitor can be regarded as being in control of a pure seed supply farm since pure line paddy was supplied in the first instance and it has been stipulated

that careful roguing has to be performed. Some of the best quality seed from these farms will be bought, stored in a paddy barn and used to augment the district supply of seed paddy at the next planting season.

The competition for miscellaneous farming on the West Bank has not been eagerly received. This may be due largely to the fact that this locality is largely concerned in coffee production and, as there has been a slump in prices for this commodity, there seemed to be some luke-warmness temporarily towards matters agricultural.

The possibilities of encouraging tobacco cultivation as an auxillary crop to coffee in this area are being investigated. As certain of the cultural operations such as suckering, topping and curing are not well understood in the district it is intended to start a number of plots to be run by farmers under the supervision of the agricultural officer.

The routine duties of the six co-operative credit banks of which I am Chairman—Good Intent, Canal No. 1, Vreed-en-Hoop, Den Amstel, Vergenoegen and Leguan—were carried out. During the period instructions were received to take steps to make a special effort to collect all long outstanding debts. On account of the legal action taken, in cases where necessary, the sums collected (recovered) by certain of the banks may be regarded as satisfactory, but the collections by banks in the rice-growing areas were low as most debtors, who are also rice farmers, have heavy financial demands during the sowing and transplanting seasons.

H. D. HUGGINS,
(Ag.) Agricultural Superintendent,
West Demerara.

BERBICE.

Visits in connection with experimental extension and advisory work have been paid throughout the period by all officers, and the entire district has been covered as follows :—

Estates—13 visits.
Berbice River District—5 visits.
Villages—47 visits.

Experimental Work—The following items in connection with sugar cane were dealt with :—

A. At Pln. Port Mourant a new variety trial with 12 varieties was planted as a randomised block in May.

B. Also a new variety trial was planted at Pln. Blairmont with varieties as a randomised block in May. In April a manurial trial on the same estate was reaped and ratoons remanured.

Its proximity to Georgetown enables them to obtain casual work, and on days when there is no work in town they can work on their allotments. Fifty-eight allotments have been given out of approximately ½ of an acre each ; of these fifteen are being worked by ex-service soldiers. An irrigation canal and a drainage trench have been dug on a co-operative basis, *i.e.*, 50% of the cost has been met by Government and 50% has been given in free labour by the settlers. A good start has been made. Eight allotments have had to be taken away from original farmers ; but these have been reissued. Permission has been obtained from the Lamaha Commissioners to put down an intake koker so as to obtain irrigation water from the Lamaha Conservancy for the dry season. The ex-Service men are displaying great zeal.

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C. Progress of the previous or earlier planted manurial trial at Port Mourant and variety trials (one at Port Mourant and one at Blairmont) was noted. The two latter will be reaped at the next grinding.

D. Plantations Skeldon and Springlands were visited in April.

E. A manurial trial with Sweet Potatoes was laid out on the Prison Farms with sulphate of ammonia, superphosphate and sulphate of potash in the month of June. This trial can be readily inspected by passersby on the roadside and has been a source of interest. An excursion of school-boys was conducted over the plots and the various treatments explained. Whilst sulphate of ammonia soon produced a luxurious top growth, no forecast of results can be accurate. Final reaping is the only test, and results obtained should be of benefit to small farmers in particular.

Extension, demonstration and advisory work—The period under review was marked with activity amongst Rice Farmers and two blocks of pure seed paddy which are being conducted by the Department for later extension as seed farms were sown.

The crops when transplanted will approximate to 20 acres. Pure line paddy was also distributed to farmers at various points throughout the district for demonstration purposes.

Nurseries of Guatemala fodder grass were started for further propagation and distribution to persons interested.

A demonstration area, which was started on the sand reef at Hogstye on behalf of the proprietor, has done well. Cabbages, tomatoes and black eye peas made good growth and have been a source of interest to the neighbourhood.

Arrangements for the distribution of potato slips to farmers were inaugurated by courtesy of the Keeper of the Prison.

General advisory work was conducted by all officers in the course of their visits to villages and meetings of farmers were held on various occasions where matters of interest were freely discussed.

The Port Mourant Boys' Club plot was visited on several occasions and some progress was noted.

Agricultural Competitions—These competitions were started. Two with pure seed paddy at No. 70-72 Corentyne and Bush Lot, West Coast, Berbice.

The former was started with 14 farmers but unfortunately only two were able to transplant their seedlings owing to the ravages or ducks, which constitute a severe pest in the District. The two surviving plots will be inspected and their owners, it is hoped, will become pure seed farmers and suppliers,

The other paddy competition at Bush Lot, West Coast Berbice, is a success and was entered into with spirit. 44 names were recorded and 40 plots have been planted out of half an acre each.

As this is a total of 20 acres of pure seed which will be available it is hoped that all will be sold as seed and not as rice.

On the East Bank, Berbice River, 15 names were recorded for the miscellaneous farm competition. This is gratifying and a distinct improvement on last year when only eight names were recorded.

Co-operative Credit.—Eight banks were in operation in the district. Monthly meetings were held at seven of these. The eighth at Eldorado, West Coast Berbice, owing to amount of outstanding debts had to be closed down for mending up purposes and an agent appointed for collection of debts.

Rice Grading.—The following is a resumé of quantities of rice exported at New Amsterdam :—

	No. 2	*No. 3*	*Broken*	*Totals*
April	1,348	512	335	2,195
May	2,045	60	—	2,105
June	2,450	150	—	2,600
	5,843	722	335	6,900

H. MACLUSKIE,
Agricultural Superintendent,
Berbice.

ESSEQUIBO.

The Experimental Station—Henrietta.—Work was commenced on laying out the Manurial Experiment and the Varietal Trial as soon as sufficient rain had fallen to enable ploughing to start.

The layout of the manurial experiment took a considerable time, great accuracy being necessary, as each plot had to be a self-contained paddy bed with meres. This work and also the mixing of the manures was carried out by the Assistant Superintendent. All land preparation was completed by the end of June.

THE BUSH LOT SETTLEMENT.

Instruction has been continued in gardening and vegetable production, but during the period under review the settlers were mostly concerned with the planting of their paddy crop.

Instruction was given in the preparation of nurseries, of the treatment of seed prior to sowing, and the manuring of nurseries.

Cultivators were urged to commence "dry ploughing." This was done whereever possible with the Hindustan or steel plough. Where this work was

carried out costs of cultivation were reduced, as far more can be ploughed per day under dry conditions.

The demonstration provision farm was planted up during April and May, and instruction given in the planting of yams and other root crops. Few of the settlers know anything of provision cultivation and the demonstration farm has served a useful purpose. Crops are being raised with a view to establishing a future planting material centre.

Co-operative Credit Societies.—Monthly meetings of the Committees of the three Banks in the Essequibo District have been held, and meetings of shareholders addressed.

General.—Work in the District has been almost entirely confined to the question of the distribution of pure line seed paddy of the Blue Stick variety, and the establishment of private seed farms, from which all paddy growers in the district may eventually be supplied.

Travelling.—During the period under review 850 miles have been covered in the District and Wakenaam Island, by the Superintendent of Agriculture and 930 miles by the Assistant Superintendent.

All estates have been visited at least twice per month in connection with the Seed Paddy Distribution Scheme.

Rice Grading.—A rice grading Office was opened at Anna Regina during June. This is proving of great assistance to some rice millers on the Coast, who are now able to ship their milled rice direct to the outgoing steamer, thus saving a considerable amount of handling in Georgetown, and also assisting in the reduction of overhead costs.

Anna Regina Estates.—The running of the Anna Regina Estate by the Agricultural Superintendent has been continued.

A. deK. FRAMPTON,
Agricultural Superintendent,
Essequibo.

NORTH WEST DISTRICT.

Farmers have made complaints to the effect that considerable areas lying aback of their grants (as laid out on the 89 rods x 33 rods system for a 10-acre grant) were unsuitable for cultivation. Representations were made to the Commissioner and a survey was made mapping out the infertile areas.

Lime and citrus cultivation in general has received the attention of the farmers who are investigating the possibilities of any alternative crop to substitute for Liberian coffee. On the hill lands approximately 1,600 lime plants budded on sour orange stock were planted out while a number of lime seedlings were taken by farmers from the Hosororo Experiment Station for trial on the pegasse land. Although somewhat sceptical about the success of these plants the farmers have shown a desire to co-operate with the Experiment Station in testing their possibilities.

The newly formed North West Farmers' Co-operative Marketing Association met with success during this initiation period. The project was whole-heartedly supported by the farmers in the district and it was possible to obtain, for the growers, a more remunerative price for their ground provisions than they had previously received.

Of the two areas of 100 acres each which were set aside for occupation by the farmers in 5-acre lots (Free Farms) about 15 lots were taken up in the Aruka block but little work was done during this quarter as the weather was not considered suitable to the requirements of land reclamation. Owing to the large amount of land held by the several farmers in the Barima river district no land was occupied in the Barima block.

Coffee picking practically ceased during May but it must be noted that, owing to depressed prices, a comparatively large amount of coffee was not picked. Indications for the coming crop are favourable although any damage done to the bearing capacity of the trees due to the incompleteness of the picking will not show till later.

Hosororo and Wauna Stations.—This being the most suitable season for planting, the various orders for citrus, etc., as explained above, had to be met as much as possible and basketing was pushed forward. Difficulty was experienced when farmers did not take delivery of the plants for some time after basketing.

At Wauna three and a half acres of citrus, on sandy soil, were planted out for experimental purposes. This group consisted of oranges and grapefruit on rough lemon stock and limes, grapefruit and oranges on sour orange stocks. The growth made by the plants, during the first few months subsequent to transplanting, was remarkable. It was appreciated that this vigour, without any set back was due in some measure to the thoroughness of preparation of the holes and the care taken during transplanting.

The extension of the ground provision trials proceeded along with the planting up of Pigeon Pea and Crotalaria cover crops. In this trial it is hoped to demonstrate that by proper rotational and cultural methods it is possible to obtain such a yield from provision crops as will make green manure and mulching of economic expenditure. The trial of ground provisions includes Avocado Pears, Citrus and Tung Oil Plants which, so far, have not been experimented with on pegasse lands in this district.

Advantage was taken of the rainy months to supply vacancies on the area planted with fish poison plants. At Wauna a good stand of Haiari under shade was established.

Routine work of weeding, mulching, pruning, etc., was carried on where necessary.

J. D. GILLESPIE,
Agricultural Superintendent,
North West District.

NOTES.

Soaking Cane Cuttings :—In *Sugar News* for July 1931, Dr. Atherton Lee reports an experiment in which the germination obtained from P.O.J. 2878 cuttings (the top two or three plants from each stalk) unsoaked, and soaked for different periods in clear water are compared. The experiment covered just over six acres and each plot was somewhat over a tenth of an acre in area. There were several replicates of each treatment. The results point to a twelve-hour soaking as being most satisfactory, giving about eight per cent. better germination and, at four months, 33 per cent. more stalks per hectare than no soaking.

C.H.B.W.

Green Manures for Cane :—At the Fourth Meeting of the South African Sugar Technologists Association, the Natal Sugar Experiment Station reported the results of a green manuring trial executed on an area which had been continuously under cane for 50 years except for a three-year-period under wattle trees, the soil being a heavy clay loam of very poor drainage qualities. The land was thoroughly prepared by ploughing, cross-plouging and harrowing in October and November 1926 and all sections given 450 lb. rock phosphate and 60 lb. sulphate of potash per acre, broadcast and harrowed in. Then the controls were allowed to lie fallow (a heavy growth of weeds soon covered them) while other plots were planted to various legume and non-legume green manures. In October 1927 the field was harrowed and furrowed for planting and 250 lb. superphosphate per acre was applied to the whole field in the furrows on November 1st. Cane was planted on November 14th and by December 9th a good germination was noted. The final results were as follows :—

Treatment	*Yield in tons of Cane per Acre.*	*No. of Plots*	*Standard Deviation from mean.*	*Standard experimental error*
Plain Fallow No green manure	39.20	6	25.3	1.03
Green Manure Non-legume	41.22	6	2.45	1.00
Green Manure Legume	43.13	15	1.76	0.45

C.H.B.W.

The Preparation of Coffee :—Camplaints are continually being made about the preparation of Liberian Coffee in Suriname. The unpleasant aroma and the

sour and rather tasteless flavour of this coffee is the reason (according to the manufacturers) why it has such a limited market (in one part of Scandanavia only). It is even prophesied that with the intensification of production, this price will drop rapidly and indeed the product become unsaleable.

As regards the results of the investigation undertaken by me to determine the causes of the undesirable properties of our Liberian coffee, a report was made (Communication No. 3) so that it is only necessary here for me to give a brief resumé.

1. No relationship was found to exist between the fermentation process and the quality of this coffee. It was found that Liberian coffee, free from these undesirable properties, can be prepared whether the coffee is fermented or not.

2. A new washer was constructed whereby the coffee can be quickly cleaned of its mucilage without the beans being broken. By leaving out fermentation the following advantages are to be obtained :—

(a) The fermentation troughs which take up a good deal of room in the factory can be dispensed with.

(b) The drying becomes more rapid since the beans absorb water during the fermentation process and can only be dried at the expense of using fuel.

3. It appears that our coffee has to be dried quickly and heated to a temperature of about 80° C. in order that it might be free of the undesirable properties named above. Most likely this undesirable flavour and aroma is the result of enzymatic changes in the beans. Under the old system the beans were dried slowly (20-30 hours) and at end temperature of 60-65°C. so that the enzymes remained in an optimum condition for a longer time. By drying quickly one can avoid this splitting of the enzymes for at a temperature of 80°C. these enzymes become inactive.

4. By replacing steam heaters by cradles directly heated by flame we can dry at a higher temperature. Furthermore, the drying process can be markedly accelerated by allowing the cradles or drums to turn at a higher speed for example 6 to 8 revolutions per minute in place of 1 to 2.

In the factory at Slookwyk and Clevia this recommendation was adopted and the drying process brought down from 20 to 25 to about 10 to 12 hours. By eliminating the fermentation process and by the application of a new drying method it appears possible to prepare market coffee ranging in quality from the best coffee to low grade coffee within 24 hours. This coffee has then to be sorted. In the old process this preparation takes from 5 to 6 days.

5. It is possible to dry the coffee so as to obtain a definite colour.

19 lots of coffee were prepared according to the new method and sent to manufacturers in Europe and America to obtain their opinions. The practical investigations of the manufacturers gave grounds for the following conclusions :—

(a) **The unburnt coffee is free from undesirable aroma.**

(b) **The sour flavour disappears.**

(c) **No recommendation can be made at present as to the colour that should be given to our coffee since the value of every colour depends upon the country where the coffee is sold.**

Report of Department of Agriculture, Surinam (1928-30).
(Translation by F. A. SQUIRE, B. Sc., F.E.S.)

Preliminary Report on the Rice Weevil:—The investigation was started towards the middle of July of the current year. Mills were visited in Berbice, on the East Coast and in Essequibo, and periodic inspections made of the warehouses and wharves in Georgetown. As is naturally to be expected, the insect is found in all such places in various degrees of abundance depending usually on the conditions of storage and the length of time for which the crop is stored. Some warehouses and mills occasionally enjoy periods of freedom from weevils. The cause of this temporary subsidence of attack is not understood but appears, in some cases at least, to be correlated with the moisture of the grain. That the storehouses get rid of the weevils and are subsequently reinfected from outside is an unlikely possibility.

It is generally known that weevil infested rice can be recognised by the white frangible grains filled with floury frass. Contrary to general belief, however, the absence of such grains does not necessarily mean that the rice is clean especially when it has just been hulled, since weevils in the egg and early larval stage are not readily seen. In the ordinary way it would be very unusual to find only these immature forms, unaccompanied by the white frangible grains and the adults, but the effect of hulling is to eliminate the attenuated grains as well as the imagines, yielding a product apparently weevil free. If such grain be kept for 2 or 3 weeks the familiar symptoms of weevil attack will appear and in due course there will be an emergence of adult weevils.

SOURCES OF INFECTION.

In the Mills.—Since the root of the evil lies in the mills, from which contaminated rice is always being passed out to the warehouses, this is the most natural point for assailing the problem. In this endeavour a knowledge of the sources of infection is of prime importance.

Once the insect has established itself in the building, infection may be carried over to clean paddy in a number of ways.

Firstly it must be remembered that the adult weevil has a fairly long life; that it is capable of migrating from bag to bag and that it would probably be attracted by paddy brought in last and not quite so dry.

Secondly the practice of storing rice and paddy together in the mills is frought with danger. Since rice is very susceptible to weevil attack it should be

stored with greater care. Moreover once infested with weevils a few bags of rice may contaminate a very large quantity of paddy.

Milling machinery is also a potential source of infection since weevily grains left behind in various parts of the machinery are liable to be mixed with batches of paddy passed through afterwards.

Bags are dangerous since imagines are liable to be carried about in them.

In the Warehouses.—Conditions are rather different owing to the absence of machinery and stored paddy. Here the chief danger is from infected rice sent in from the mills.

Recommendations.—The following measures are recommended in the control of the rice weevil ;—

1. In storing rice or paddy care should be taken to use clean bags.
2. New grain should not be mixed with old.
3. All stored grain should be thoroughly dry.
4. Floors should be kept clean and the bags raised on beams.
5. As much light as possible should be admitted. Light is inimical to weevils.
6. As far as possible the mills should be kept clean.
7. Hulling is an effective means of getting rid of infected grains and weevils. Rice may profitably be passed through the huller with this in view. Only the more mature larvæ, pupæ, and adults are eliminated, however ; so that the process if repeated about 15 days after so as to catch the younger generation would be very much more effective.

Care should be taken to destroy the weevils passed out with the powdered grains by the huller. It is a common practice to spray the heap underneath the huller. This is of little or no value as most of the weevils are not reached by the spray and of those that are reached very few are killed.

The two conditions predisposing grain to weevil attack are darkness and moisture.

The investigation is proceeding.

F.A.S.

Kawisari B Coffee.—In the *Philippine Agriculturist,* Vol. XX No. 2, N.B. Mendiola describes a hybrid, between Arabian and Liberian coffees, which was introduced into the Philippines. The cross appears to have occurred naturally on an estate—Kawisari—in Java where only Arabian and Liberian coffees were cultivated. From seeds of Liberian trees there arose certain plants which differed from the parents and which proved to be natural hybrids. Of these

hybrids one known as Kawisari B. appeared to possess most commercial possibilities for altitudes above 1,100 ft. and Kawisari D for lower elevations.

The important desirable characteristics of these hybirds are :—

(1) They are practically immune to the attack of coffee rust (*Hemileia vastatrix* Berkeley and Broome.)

(2) They give coffee which is inferior in quality only to Arabian and which commands a better price than Liberian, Robusta and other commercial varieties except Arabian.

(3) They exhibit strong, vigorous growth and ability to endure unfavourable climate and soil conditions.

(4) They are constant croppers. Their yield is said to be 450 to 530 lbs. of coffee per acre.

The important undesirable characteristics of these hybirds are that, as in the case of Liberian, the berries require artificial drying to make possible the easy removal of the silver skin and that these hybrids are more susceptible to the attacks of the coffee bean borer.

The Kawisari B. berries are usually red but sometimes are yellow when ripe and are larger than Robusta berries but smaller than those of Excelsa and Liberian. Below is given a table showing (a) the ratio of ripe berries to market coffee and (b) the weight of market coffee produced from a kerosene tin of fresh berries for four other species for comparison.

	Weight of fresh berries required to make 1 lb. of market coffee. Lbs.	*Weight of market coffee produced from 1 kerosene tin of fresh berries* Lbs.
Arabica	5	...
Excelsa	5.82	4.6
Robusta	4.31	6.5
Liberica	9.90	2.7
Kawisari B.	6.13	3·9

H.D.H.

Grape Vine Culture:—As a number of applications have been made from time to time to this Department for information on grape culture the following particulars of its cultivation are given below.

The grape vine grows wild in the temperate and semi-tropical regions of Northern Africa, Southern Europe and Western Asia. This vine appears to do best in those coastal areas slightly above sea level where the temperature tends to be more equable and not subjected to the marked fluctuations in tempearture occurring during the days and nights in hilly localities.

The plants are normally propagated by means of cuttings selected from wood about the size of a man's little finger. The number of buds left to each cutting varies, but good results are to be obtained if two joints—*i.e.*, two buds—are used. Smooth cuts should be made close to the buds so that practically no wood is left above or below the two joints or nodes.

It is advisable at the beginning to plant the cuttings in a well prepared nursery and not in their permanent positions immediately. Cuttings should be inserted in the soil about 3 inches apart so that one eye is above the surface of the soil and the other one below ground. When a growth of 4.5 inches has been made the cuttings should be lifted and potted or, as is frequently done, transferred to their permanent positions in the field.

In order that the vine may have a good start, a hole 6′ x 6′ or 6′ x 4′ and 1½′ deep should be dug. If the soil is heavy a mixture of lighter and more friable soil (if possible sand), wood ashes and well rotted stable manure should be well mixed and applied. This mixed soil should be thoroughly watered and allowed to stand for a few days before planting. When the young plants are being transplanted it is most essential that the soil be not too tightly pressed around the roots.

The plants should be spaced 4′ x 5′ apart and the site selected should be such that an abundance of sunlight can be obtained.

After a vine has been planted out in the field for about 10—12 months it should be pruned back to the most vigorous bud—generally the lowest and about 3 inches from the surface of the ground. During the first year of its growth a strong straight stick is all that is necessary for the plant to climb on. As the vine grows it throws out side branches which should be pinched off regularly and not allowed to form more than 2-3 leaves. As new shoots appear all excepting the strongest should be cut out in order to obtain a well grown plant. Immediately after pruning, the wood should be thoroughly cleaned and washed with some mixture such as soap, water and sulphur to control pests and diseases. Well rotted pen manure should now be added around the roots and liberal waterings given at intervals until vigorous growth is re-established.

It is important towards the end of the second year of growth that the roots be kept as dry as possible and only final pruning be done for fruit. The main stem should be kept as straight as possible and the side shoots should be cut back to a vigorous looking bud close to the old wood of the main stem, it being borne in mind that the fruit of this year will be borne on the wood of last year.

A good type of arbour may be made as follows :—Insert four moderately stout posts into the ground at 4′ apart ; fasten a piece of 4″ x 4″ scantling to the top of these to serve as the end of this arbour ; make a similar erection 25′ away and stretch wires, eighteen inches apart, from the tops of the scantlings.

If the front of the arbour is about 4½' high and the back 6' a suitable slope will be obtained.

As soon as the vine begins to send out its shoots care must be taken to pinch off all buds that are not required, and when the shoots are about three inches in length it is probable that indications of fruit will then be observed on the growth. After the fruit has set careful thinning out is essential. Ordinarily one-third to one-half of the fruit may be cut out and the operation of thinning may be satisfactorily performed as follows:—

Procure a small cleft or forked stick about 6 inches long for use in the left hand, in order to hold the bunch firmly without touching it, and use a pair of grape scissors in the right hand. Trim the bunch into proper shape and cut out all the inner berries, then all the small berries, and then the side berries. Care should be taken not to make the bunches too thin; loose spreading bunches are objectionable and easily damaged.

Control of Coconut Caterpillar:—From the 12th to the 16th August, a thorough inspection was made of plantations on the East Coast, Demerara, during which house to house visits were paid and the people actually taken into their own fields and shown the nests where present. It appears, however, that very little effort is made by these small holders to control the pest in the absence of direct supervision.

On the 24th. of August another tour of inspection was made around the larger holdings and the degree of infestation and the conditions obtaining ascertained.

LETTER T.

The trees are recovering but slowly from the last attack.

The pest is most abundant in the butterfly stage at present. These are being collected and destroyed fairly thoroughly. In a few small areas various cover crops have been planted with the result that these areas are kept clean.

PARK ESTATE.

Caterpillars are still being collected in small numbers at Sophia's Hope, the rest of the estate being practically free from the pest.

DRILL ESTATE.

Here the attack appears to have subsided almost entirely.

Using the same empirical scale proposed in the Report of July 27, we propose the following figures to represent the degree of infestation.

Little Abary and vicinity	8	degrees.
Sophia's Hope	2	„
Ormsary and Serek	3	„

F.A.S.

DEPARTMENTAL NOTES.

His Excellency the Governor accompanied by the Acting Director of Agriculture left by the C. T. S. "Tarpon" on June 30, on a tour of the North West District; the party travelled overland inspecting the Pomeroon and Essequibo coastal districts.

His Excellency also visited sub-Station Cecilia, the 4-H Club agricultural plot at Beterverwagting, the vegetable garden plots at Lodge Village, and the Rice Experiment Station.

The Acting Director of Agriculture, the Hon. F. Burnett, M.C., M. A., was on circuit from August 4 to August 6 inclusive. He visited Beterverwagting, Golden Grove, Mahaicony (East Coast Demerara), West Coast Berbice, the Corentyne, New Forest, Canje, and Mara, Berbice River. He also paid special visits to the 4-H Club at Beterverwagting, Pln. Cecilia and the Essequibo District.

Professor J. S. Dash, B.S.A., attended the Conference of Directors of Agriculture held in London, July 14 and 17. This conference was held under the chairmanship of the Agricultural Adviser to the Secretary of State for the Colonies (Mr. F. A. Stockdale, C.B.E., M.A.).

Professor Dash also attended the Imperial Sugar Cane Research Conference in London.

Mr. L. D. Cleare, F.L.S., F.E.S., formerly Entomologist to this Department and now seconded by the Empire Marketing Board for research on the control of sugar cane moth borers, has moved into the newly constructed laboratory at Sophia.

Mr. F. A. Squire, B.Sc. (S.A.), F.E.S., has been appointed Supernumerary Entomologist in this Department and arrived in the Colony on July 8.

Mr. Squire has paid inspection visits to Mahaicony, New Amsterdam, Berbice, and the Essequibo Coast.

Mr. J. F. Williams, Dip. Agr. (I.C.T.A.), has been employed by Messrs. Booker Bros., McConnell and Co., Ltd., to carry out a soil survey of their cane soils throughout the Colony. This work is being done under the direction of the Chemical Division of this Department.

During the period under review, Mr. E. M. Peterkin, Agricultural Superintendent, East Demerara, was granted eleven days' sick leave which he spent in Barbados.

Mr. C. H. B. Williams, Dip. Agr. (I.C.T.A.), Cane Agronomist, returned from his tour of the West Indian sugar producing Islands on August 5, 1931. A report of his visit appears elsewhere in this Journal.

Capt. E. Beckett, F.L.S., Agricultural Superintendent, North West District, returned from long leave on August 11. Arrangements were made for this officer to spend a short period in Trinidad in order to inspect the progress being made with the citrus industry in that Colony; a report by this officer is presented in this issue.

Consequent on the return of Capt. Beckett, Mr. J. D. Gillepie, B.Sc., has returned to the West Demerara District and Mr. H. D. Huggins, Dip. Agr. (I.C.T.A.), to the East Bank.

Mr. R. R. Follett-Smith, B.Sc., A.R.C.S., Chemist-Ecologist, who has been visiting the Experimental Station at Sophia during the absence of the Agronomist, has paid some 25 visits to that Station. He also visited Plns. Ogle (where samples of water from flooded fields were collected), Cane Grove (in connection with a soil survey of that estate) on the East Coast, Tuschen and Uitvlugt on the West Coast, the Mahaica Leper Hospital in connection with the fruiting of *Hydnocarpus anthelmintica*, Pln. Affiance, Essequibo, in order to initiate a manurial trial bearing relation to the Wilt Disease of coconuts and a number of old Dutch plantations on the banks of the Demerara river.

Major T. Bone, O.B.E., M.R.C.V.S., Government Veterinary Surgeon visited plantations on the East Coast, West Coast and East Bank, Demerara, and Berbice.

Mr. H. D. Huggins (Ag. Agricultural Superintendent) visited the area traversed by the Bartica-Kaburi road with the object of estimating the agricultural potentialities of the area. A report has since been submitted.

Mr. L. E. W. Codd, M.Sc., has been appointed Plant Breeder to this Department and arrived in the Colony on September 20.

PLANT AND SEED IMPORTATION.

THE FOLLOWING ARE RECENT INTRODUCTIONS BY THE DEPARTMENT OF AGRICULTURE.

DESCRIPTION	QUANTITY	WHENCE RECEIVED
Ornamental.		
Borassodendron Machadonis	1 Package seeds (12)	Singapore, Straits Settlements
Areca glaudiformis	do. (8)	do.
Economic.		
Calapagonium mucunoides	7 ozs. seeds	Imperial College of Tropical Agriculture, Trinidad
Pueraria javanica	5 ozs. seeds	do.
Egyptian Onion Seed	1 lb. 4 ozs.	Ministry of Agriculture, Egypt
Ilex Paraguayensis	1 Packet seeds	Buenos Aires
Citronella	100 roots	Department of Agriculture, Ceylon.
Budwood.		
Parson Brown Orange	500 buds	Department of Agriculture, Dominica
Duncan Grapefruit	500 ,,	do.
Valencia Orange	250 ,,	do.
Washington Navel Orange	200 ,,	do.
Marsh Grapefruit	250 ,,	do.
,, ,,	800 ,,	Department of Agriculture, Trinidad.
Parson Brown Orange	800 ,,	do.
Tardiff's Hart Late Orange	400 ,,	do.

EXPORTS OF AGRICULTURAL AND FOREST PRODUCTS.

Below will be found a list of the Agricultural and Forest Products of the Colony exported for the first six months during 1931.

The corresponding figures for the same period during previous years and the average for the thirteen years prior to that are added for convenience of comparison.

Product		*Average 1916-28*	*1929*	*1930*	*1931*
Sugar	tons	42,198	41,041	54,474	53,942
Rum	proof gallons	1,159,298	616,189	508,412	440,528
Molasses	gallons	315,712	1,760,043	2,242,960	4,105,380
Molascuit	tons	644	641	353	25
Rice	tons	4,892	7,264	11,147	12,247
Coconuts	thousands	996	252	220,825	689
Coconut Oil	gallons	12,367	9,388	9,738	12,847
Copra	cwts.	7,049	44,137	28,400	23,540
Coffee	cwts.	3,698	7,422	1,004	3,373
Lime Juice Concentrated	gallons	3,489	5,861	4,614	None
Essential Oil of Limes	gallons	114	367	369	292
Rubber	cwts.	59	None	46	48
Balata	cwts.	3,128	1,425	1,981	2,425
Gums	lbs.	1,201	None	787	238
Firewood—Wallaba, etc.	tons	4,257	5,196	5,913	5,537
Charcoal	bags	21,727	28,141	26,674	27,737
Railway sleepers	No.	7,750	7,701	3,369	1,225
Shingles	thousands	989	1,240	847,550	374
Lumber	ft.	88,786	73,464	67,634	104,779
Timber	cu. ft.	78,155	143,889	89,553	99,849
Cattle	Head	186	146	1,089	63
Hides	No.	3,169	3,237	3,195	2,371
Pigs	No.	213	166	516	116
Sheep	No.	19	None	None	6

CURRENT PRICES OF COLONIAL PRODUCE.

From The Commercial Review, Journal of the Georgetown Chamber of Commerce, Vol. XV, No. 2, Monday 31st August, 1931.

SUGAR.

Per 100 lbs. net 3 lbs. per Bag allowed for tare

Dark Crystals for Local Consumption..................$2.80
Yellow Crystals do. do. $3.50
White Crystals...$4.25 to $4.35
Molasses Sugar...none offering

RUM.

Imperial Gallon. Cask included.

Coloured, in Puncheons—40 to 42 O.P...(for export).....60c. Hhds. 65c. Barrels 70c.
White, in Hogsheads—10 to 45 O.P....(for local consumption)...........48 to 55c.

MOLASSES.

Per Imperial Gallon. Cask included.

Yellow (firsts).. }
Yellow (seconds)..................................... } None Offering
Dark... }

RICE.

Rice............per Bag of 180 lbs. gross, $3.25 to $5.00 as to quality.
Paddy..........per Bag of 143 lbs. gross, $1.20 to $1.75

GENERAL.

Gold, Raw,...per oz. $18 to $20.
Diamonds,—pro rata as per quality......................average per carat $13 to $14.
Timber, Gr. Heart, (Lower grade measurements)···72c. to 96c. per c. ft., for export $1.00 to $1.20 per c. ft.
Do. Railroad Sleepers—(Mora)...$1.68 each.
Greenheart Lumber..$110 per 1,000 feet
Crabwood Lumber..$60 to $75 per 1,000 feet.
Shingles, Wallaba, 4 x 20 and 5 x 22 inches,......................$4.00 to $5.00 per M.
Charcoal, Capped for shipment..60c. to 80c. per Bag.
Firewood...$2.16 to $2.50 per ton
Coconuts.........Selects, $12.00, culls......$8.00 M..................Copra, 1¾c. per lb.
Balata..................................Venezuelan, none. Local Sheet...36 to 38 cts. per lb.
Cocoa...14c. " "
Coffee..4c. " "

N.B.—Duty payable on value at time of Importation and at Rate of Exchange on day of arrival.

METEOROLOGICAL DATA—APRIL—JUNE, 1931.

Recording Stations & Months.	Rain-fall. Total Inches.	NUMBER OF DAYS OF RAIN: Under ·10 Inch	·10 to ·50 Inch	·50 to 1.00 Inch	1.00 Inch to 2.00 Inches	Above 2.00 Inches	Total days.	Evaporation. Inches	Air Temperature and Humidity: Air Temp. Maximum.	Minimum.	Mean	Humidity. Mean
Botanic Gardens.												
April ...	1·27	3	3	1	...	...	7	7·84	87·9	77·6	82·7	74·3
May ...	11·49	5	9	6	2	1	23	5·21	85·7	76·9	81·3	82·8
June ...	11·47	7	6	7	3	...	23	3·92	85·6	75·2	80·9	84·8
Totals	24·23	15	18	14	5	1	53	16·97				
Means.	...	...	...	...	...	...	...	...	86·4	76·9	81·6	80·6
Berbice Gardens.												
April ...	6·51	...	2	2	3	...	7	...	85·2	76·4	8·08	77·3
May ..	16·43	5	5	3	6	2	21	...	87·5	76·3	81·9	81·5
June ...	9·89	9	7	3	4	...	23	...	88·3	75·7	82·0	80·4
Totals	32·83	14	14	8	13	2	51	...				
Means.	...	...	...	...	...	...	...	...	87·0	76.1	81·6	79·7
Onderneeming.												
April .	2·29	2	5	1	...	...	8	...	88·4	74·2	81·3	86·2
May ...	12·03	1	5	6	4	...	16	...	89·1	74·8	81·9	85·9
June ...	11·48	...	9	3	4	...	16	...	88·8	74·5	81·6	84·6
Totals	25·80	3	19	10	8	...	40	...				
Means.	...	...	...	...	...	...	...	...	88·8	74·5	81·6	85·6
Morawhanna, N.W.D.												
April ...	4·13	2	7	1	...	1	11	...	...	...	...	...
May ...	7·10	4	5	4	2	...	15	...	...	...	...	...
June ...	11·65	5	15	8	1	...	29	...	...	...	...	...
Totals	22·88	11	27	13	3	1	55	...	...	...	...	...

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The Agricultural Journal of British Guiana

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In collaboration with the Officers of the Department of Agriculture.

CONTENTS.

(Vol. IV, No. 4.)

NOTICE

SUSPENSION OF PUBLICATION OF *THE AGRICULTURAL JOURNAL OF BRITISH GUIANA.*

The *Agricultural Journal of British Guiana* was first published in March 1928.

In Sessional Paper No. $\frac{16A}{1927}$ the policy of the new Journal was stated and it was then announced that results of agricultural experiments would be made a special feature, while information of a more popular nature would be distributed through the medium of the press, simply worded leaflets and the district staff. With this policy the Journal was started and with this policy it has continued, for, in the words of the Editorial of this issue (see p. 180) "Unfortunately, no shorter method than trial and experiment has yet been discovered which will permit the scientific worker accurately to answer questions such as these :—"Will this crop grow in that situation ?", "Will this manure give satisfactory results on that soil ?", "Is this variety a better yielder than that one ?". To answer these and similar questions, scientific experiments must be laid down and the results examined in such a manner as to disclose the true significance of these results. That this is the only means by which the scientist may approach these problems is not always realised by the lay worker, and it is lack of appreciation of this fact which is mainly responsible for the impatience so frequently exhibited towards the efforts of Agricultural Departments."

This Journal has had to perform very diverse functions. It has been a useful means of distributing information to local agriculturists ; the record of the work undertaken and conclusions drawn to which most easy reference can be made; a reciprocating medium between this and other overseas Agricultural Departments ; in exchange for it, publications have been received from most Agricultural Departments of the tropics.

It is, therefore, with the greatest regret that it now has to be announced that Government, as an economic measure, has decided to suspend publication of the Agricultural Journal of British Guiana.

This notice serves as an intimation to all those, both in and out of the Colony, who have supported the Journal, that after the present issue there will be no appearance until further notice.

We are deeply grateful for the appreciation expressed in letters and in other ways of the value of the Journal to agriculturists throughout the tropical Empire.

Sydney Dash

Director of Agriculture.

The
Agricultural Journal of British Guiana.
December, 1931.

EDITORIAL.

THE DEMAND FOR A NEW CROP.

The minds of most individuals and of most institutions in the civilized world to-day are directed towards the alleviation of the industrial depression. This depression was precipitated, if not caused, by the disruption of the order, systems and organisations of civilization brought about by the Great War of 1914–18. This depression has resulted in conflicting and distressing effects—labour forced to involuntary idleness on the one hand, capital accumulated and compelled to lie idle on the other, want and starvation among some, over-production of food material and other raw products among others.

It is not the intention, nor within the province, of this Journal to philosophize on the economic situation of the world in general. Nevertheless, so intimately is the commerce of even small and obscure countries bound up with that of the rest of the world that this situation—a situation over which British Guiana has little or no control—has directly affected all phases of local industry. It is this situation which is responsible for the demand now being made so insistently by the local agriculturist that a new crop be found for British Guiana—a crop that will give profitable employment to our people and prosperity to our land.

It is not only in the sugar, rice, coconut, coffee and livestock industries—our own important agricultural industries—that it is now necessary to exercise the sternest economies if remunerative business is to be maintained, and hence one has not far to look for prototypes of this demand. Industrial depression, common to communities differing widely in situation, has led to unrest among nations with the consequent demand for new governments; to recurrent annual losses by rail and steamship companies throughout the world with the resultant innovations, reports of which have become a feature of the morning's paper; to demands for frantic and expensive efforts with beet culture in England and to numerous other demands resulting from the unhealthy condition of world economics.

In these eventful times, since this is an agricultural country, it is not surprising that a request is made, and made insistently, for a new crop to be forthcoming. Nevertheless, as insistent as these demands are, it is not generally apprehended what are the circumstances leading to the introduction of a new crop into a country by an Agricultural Department. In the first place a crop is

considered for introduction either if an agricultural officer has previously observed the crop growing and displaying characters which suggest that it would be suited to the environment, labour conditions, etc., under consideration, or if an officer reads or hears of a crop which is likely to fulfil the necessary requirements. Planting material is then obtained and trials made with the new crop in the new situation before any pronouncement can or should be made.

There are many instances, in the course of tropical agricultural history, when crops have been introduced with a blare of trumpets from one country to another, to reputedly similar conditions, but have failed to rise to expectations and to maintain that reputation which caused their introduction. Almost invariably this has been due to insufficient time being given to preliminary trials.

Since significance must necessarily be attached to the recommendations of an Agricultural Department in respect to the extension or otherwise of a new crop, recommendations cannot be advanced solely on the opinion or belief of an officer, but may be made only after trial and observation of the new crop in its new situation. Harland wrote "one needs.........to realise that the question whether a district will or will not grow cotton can at present be settled only by experiment," and this is applicable to all agricultural crops to be grown on a commercial basis.

Unfortunately, no shorter method than trial and experiment has yet been discovered which will permit the scientific worker accurately to answer questions such as these :—"Will this crop grow in that situation ?", "Will this manure give satisfactory results on that soil ?", "Is this variety a better yielder than that one ?". To answer these and similar questions, scientific experiments must be laid down and the results examined in such a manner as to disclose the true significance of those results. That this is the only means by which the scientist may approach these problems is not always realised by the lay worker, and it is lack of appreciation of this fact which is mainly responsible for the uninformed criticism often expressed and the impatience so frequently exhibited towards the efforts of Agricultural Departments.

Moreover, it must not be lost sight of that a reasonable pre-requisite for the consideration of a new crop for a country is that the conditions, under which the crop is known to have succeeded, should bear some similarity to those of the country of adoption. Although the conditions in British Guiana are not unique there are few other tropical areas which have to contend with environmental factors such as ours—heavy clay soils, highly leached, markedly acid and below sea-level. With the exception of certain portions of Dutch Guiana and of Malaya we do not easily call to mind any tropical areas which, in this respect, bear resemblance to ours.

This fact appreciably enhances the difficulties of the selection or of the discovery of a new crop for this colony. Nevertheless, even were these obstacles circumvented, a study of tropical agricultural affairs discloses that remarkably few crops, at the present time, are giving to the inhabitants of the

country in which they grow a more profitable means of livelihood than are our crops to our people.

The following short notes on some important tropical crops, not grown extensively in British Guiana, serve to give some idea of the economic situation in the several countries which produce these crops :

In the Gold Coast, "the fall in the price of cacao affected not only the export but also the import trade by reducing considerably the purchasing power of the people."

On account of the slump in prices, Ceylon reduced her export of tea by 10,000,000 lbs. last year. The stocks of this commodity in Great Britain alone have reached 225,000,000 lbs.

In Tanganyika, "the heavy fall in the prices of sisal gravely affected Government's finance and trade purchasing power."

At the end of the 1931 cotton crop a surplus of at least 12,000.000 bales was foreshadowed.

The Kenya legislature has provided a loan to supply a subsidy of approximately two shillings to the growers of Indian corn for every bag exported.

Growers of pimento in Jamaica do not receive more than 8s. 4d. per 100 lbs. and this is hardly sufficient to pay labour costs.

The already colossal surplus stocks of rubber have increased in the past year by 150,000 tons.

Therefore, although it is advisable to make every effort to obtain and introduce a new crop which is likely to be of benefit to the community, the indication is that an Agricultural Department at this time should primarily address itself to the problems of, and the lines of improvement for, the crop or crops already established. It should therefore be of interest to examine the situation with regard to our cultivated crops and determine what, if any, progress has been made and improvements effected.

Sugar reached its peak of production last year, 127,764 tons having been produced. This fact is especially significant if a comparison of acreages is made. There were approximately 11,000 acres more under cultivation at the beginning of the present century than there are now, yet today the Colony's production is greater. There was a marked reduction in the acreage under sugar locally from 1923, at which time, and for some years after, there was a corresponding drop in production. The recent increases in production are due very largely to the improved yields which are being obtained ; five years ago the average yield for the Colony seldom exceeded 1.75 tons of sugar per acre ; last year the average was 2.5 tons per acre.

It is not as easy accurately to estimate the production of rice, but Customs reports show that more rice was exported in 1930 than in any previous year. Further, it is recognised both locally and abroad that the quality of "Demerara

Rice" has been raised to an appreciably higher standard within recent years. Nor should there be any difficulty in maintaining this high standard, since the Department now has seed farms and seed barns established in the important rice-growing districts; the farmer, therefore, is provided with every facility for obtaining regular supplies of selected seed. In addition, thanks to a grant from the Colonial Development Fund, there is shortly to be erected a modern rice factory in which it will be possible to make commercial trials with white rice. Further, the Plant Breeder, generously provided by the Empire Marketing Board, is charged with the important work of finding a short age paddy which will make two crops of rice per annum a practical certainty, at least in those districts devoted entirely to rice growing.

With reference to coconuts, attention has been drawn previously to the consistent increase which has taken place from the early years of the present century in the area under cultivation of this crop.

There are also hopeful signs among the minor industries—citrus, tobacco, pineapples, poultry, etc., but our minor industries and their development we hope to discuss at a future date.

The rational corollary to this discussion is the question :—What, then, is the immediate agricultural outlook for British Guiana ?

Sugar-cane is one of the few crops known to thrive on our heavy, acid, low-lying clays and sugar has been our mainstay for many years. Given a reasonable chance it can still further expand, bringing within its orbit on a cane-farming plan, those areas suited to cane growing by small cultivators. Indeed given that improvement in price which we all clamour for and maintenance of trade relations with Canada—a growing Dominion—the cane industry should be regarded as a suitable means for attracting additional population from the overcrowded neighbouring islands. The yields per acre are rising, and there is every reason to believe that the new and extensive research programme recently launched will lead to still further progress. It is our opinion that there is also established the nucleus of another industry, the rice industry, which should be concentrated upon. We do not, at present, conceive of any crop which is as capable of expansion on our coastal belt as rice ; nor do we readily see another commodity which we can produce in large quantities and place on a market which is not already glutted with that commodity ; nor do we consider that a sufficiently high estimate of the value of the rice industry to the Colony has been made by our agriculturists, who should regard it as a valuable adjunct to sugar.

In rice, we possess a crop which we can grow, and which we are better suited and situated to produce than our competitors. We have a crop which we can export, and export in large quantities provided organised production and marketing are undertaken. We have a crop for which a market can be found. This is a position not enjoyed by many other countries, certainly not by our neighbours.

PURE LINE SEED PADDY DISTRIBUTION SCHEME, ESSEQUIBO DISTRICT

BY

A. deK. FRAMPTON, C.D.A.
Agricultural Superintendent, Essequibo.

INTRODUCTION.

During the planting season Autumn 1930, a varietal trial was carried out on the Henrietta Experiment Station, with the following varieties :—

Demerara Creole, Blue Stick, 76, 79, Carolina, Lady Wright, Mexican Edith, C 14—31, A 16—34, Blue Rose, H7, and 75.

The results obtained showed that the local varieties were the best yielders and of these, Demerara Creole and Blue Stick gave the highest weight of grain. The Demerara Creole variety was slightly better than the Blue Stick, but there was little to choose between them. In view of this fact, and also that Pure Line Blue Stick paddy was partially established in the District, farmers and estate proprietors were advised to keep to the Blue Stick variety. Moreover, Blue Stick is the variety on which the super rice trade of Essequibo has been built up. With the harvest of the Pure Line paddy from the Experiment Station at Henrietta, a plan for seed distribution was drawn up.

It was not possible to start this for the Spring crop, 1931, owing to the unfavourable planting conditions due to the prolonged drought.

The seed paddy was therefore stored in readiness for the planting of the Autumn crop, 1931.

SEED DISTRIBUTION PLAN.

This plan, briefly, has as its object the establishment of private seed farms throughout the District. Their function would be to act as a medium between the Department of Agriculture's Seed Station and the farmers in the District. The initial seed supply would be grown by the Department on the station, and this seed distributed to the private seed farms for multiplication and eventual distribution (after inspection) to the paddy farmers in their various localities. In this way the distribution of Pure Line seed paddy would be accelerated.

Early in the season a circular was distributed, to all estate proprietors on the Essequibo Coast and to farmers in Wakenaam, pointing out that it was impossible to meet the requirements of every estate and all farmers as regards pure line seed. It was pointed out that production at Henrietta was limited, and that, working on

paddy produced there, it would take several years before all estates and all farmers could be accommodated with pure line seed paddy, and that in the meantime the strain as grown by the ordinary farmer, who is not as particular as he should be in the matter of maintaining purity and in seed selection, would probably deteriorate.

All estates on the Coast were visited and the situation explained, orders were then booked for Pure Line seed paddy from the Department's stock at Henrietta.

As anticipated the demand exceeded the available supply by a considerable amount. Large orders were also being received from the farmers in Wakenaam Island, through the Agricultural Instructor who had been carrying on propaganda work since the beginning of the year.

The acreage under paddy on the Essequibo coast was then considered. It was found that to supply every cultivator on the coast with Pure Line Blue Stick paddy at least 2,000 bags would be needed for distribution. As it is impossible to produce that amount on the Experiment Station, each individual estate's acreage was next considered.

Working on the assumption that 2½-3 acres could be planted from one bag of seed paddy, a scale of distribution was then drawn up. The amount of seed needed by each estate to plant every acre with pure line strain was worked out. Since, as previously stated, it was impossible to produce this amount a plan was formulated whereby each estate would supply its own seed requirements. The plan was as follows :—Taking an estate of 240 acres it was seen that 80 bags of pure line seed would be necessary to plant up this area. Taking a medium yield, 5 acres would produce the amount of seed. Therefore, that estate having 240 acres was supplied with the requisite seed to plant an area which would produce 80 bags. Allowing for losses through various causes, 2 bags of pure line seed paddy from the Henrietta stocks were allowed for that estate.

In the circular distributed to estate proprietors the importance of this scheme was stressed. They were asked to distribute the pure line seed to their best cultivators only, in not less than one-acre blocks. This was later altered to not less than half-acre blocks, since it is easier for a cultivator to handle with care.

All proprietors were visited and the scheme discussed. It was impressed on them that on no account must paddy from their "seed farms" be milled into rice, as that would lead them nowhere.

Every estate proprietor agreed to co-operate with this scheme. As soon as seed distribution commenced the Agricultural Officers visited the estates. Cultivators were interviewed and advised as to the best method of treating the seed prior to sowing and also in the preparation in the nurseries.

One or two complaints were received as to the germination of the seed paddy, but this was found to be due to incorrect seed treatment prior to sowing in the

nursery. A circular was then sent out to all estates and to the farmers in Wakenaam describing the proper treatment of seed for sowing. This matter was also fully discussed with farmers, after this no further complaints were received. A book was then sent to each estate proprietor in which to record all cultural operations and observations of disease or insect pests, visits of inspection and instruction given and eventual yield obtained on the private seed farms.

Thus a complete record of each private seed farm is being kept.

It was guaranteed to visit each estate's seed farm at least once per fortnight. It was found later that this was not always possible.

It was impressed on estate proprietors that these private seed farms should be retained for each crop, fresh supplies for the farms being obtained from the Henrietta Station. In this way a standard of purity can be maintained throughout a paddy cultivation as on signs of deterioration appearing through neglect of roguing, fresh pure line seed can be distributed to all cultivators from the private seed farms.

Working on this plan it was anticipated that, at the end of this present crop, every estate should have enough pure line seed paddy to distribute to every tenant. Losses have occurred on some estates through damage by wild ducks and caterpillars, but in only one or two cases will the supply of seed be short, and this deficit can be made up by purchasing seed from Henrietta or from private seed farms in Wakenaam, where in the latter case, approximately 350 acres are under pure line seed paddy.

Apart from the Essequibo Coast, pure line seed has also been distributed in Wakenaam. On the island the position is somewhat different, there being no paddy estates as on the Essequibo Coast.

The Agricultural Instructor, Wakenaam, commenced booking orders for pure line seed early in the year, and from propaganda work already carried out and from the example set by farmers growing pure line seed the previous crop, heavy bookings were recorded which were far in excess of the stocks available.

Seed was distributed to as many farmers as possible, the same instruction being given and visits paid as in the case on the Coast. The Agricultural Instructor is keeping the same record of all seed farms in the same way as on the Coast.

The quality of the paddy on the Island was extraordinarily bad, far worse than the Essequibo Coast, and it is hoped to obtain and reserve enough pure line seed from this crop to distribute to every paddy farmer on the Island and some at Hog Island also. Thus working on the foregoing plan, a very large area of pure line Blue Stick paddy will be established from a comparatively small initial stock.

The working of this plan, the distribution of seed and visits of inspection have been the main work carried out in the Essequibo District during the past 4½

months. Visits of inspection and instruction will be carried on until all the paddy is harvested.

All seed farmers are anxious to obtain a Seed Growers' Certificate and they also are entering for the paddy competition, so a great deal of work remains to be done before the scheme is finally completed for this crop.

It may be noted here that one estate only purchased one bag of seed paddy. The proprietor of this estate had already built up a seed supply for his tenants from Pure Line Blue Stick paddy obtained from Henrietta last year. This proprietor was also selling specially selected seed paddy of excellent quality, prior to the planting of the present crop.

SEED PADDY DISTRIBUTION.

Circular I.

It is hoped that all proprietors will take a certain amount of Seed paddy from the Department of Agriculture for sowing with the coming crop.

The price has been dropped to $1.44 per bag of 143 lbs. (gross) which is approximately one cent per pound.

Herewith are appended the details of a scheme whereby all estates can be planted up with the pure line seed paddy in two crops.

The Agricultural Department has only 10 acres of paddy land at Henrietta on which to produce pure line seed and also to carry out Experiments. This is obviously not sufficient to supyly seed to the whole Coast and Wakenaam Island, therefore each estate must institute private seed farms.

For this crop there is only a limited amount of seed and numerous applications, all of which cannot be supplied. It is therefore necessary to divide up as evenly as possible what seed there is.

The following is the scheme proposed for proprietors of estates and those owning paddy land.

PRIVATE SEED FARMS FOR ESTATES FOR SUPPLYING THEIR OWN PURE LINE SEED PADDY FROM DEPARTMENT OF AGRICULTURE'S STOCK.

Circular II.

Each estate proprietor should take at least two bags of pure line seed paddy from the Department's Station.

This seed should be divided up to sow at least 5 acres. It must be sown carefully and the agricultural officers will give any help or advice that is needed.

These blocks must be specially treated and looked after since they will be the eventual seed paddy supply for the particular estate.

An Agricultural Officer will guarantee to visit the farms at least once per fortnight if it is possible, so that careful attention may be paid to the details of 'roguing' and cleaning.

Thus it is essential that only the best cultivators be given this seed.

If an estate has put in 5 acres of pure line seed paddy, this 5 acres at least should give 100 bags, which if it has been carefully managed under the Department's supervision, should be good pure line seed paddy.

This 100 bags must be carefully harvested and stored (not milled) and from it will be obtained material to plant 400 acres with pure line seed.

Thus a proprietor after purchasing two bags from the Department will be able to plant up his whole estate with pure line seed paddy from these private seed farms on his property after one crop.

The necessity for the use of pure line seed paddy is realised by everybody and above a method has been outlined whereby an estate can furnish its own seed requirements under the Department's supervision.

If the private seed farmer has carried out all instructions and if the sample of paddy harvested comes up to the required standard, then he will be issued with a certificate, that will entitle him to sell his paddy as pure line seed.

To encourage these cultivators it may be possible to pay them a slightly higher price for their paddy. The Department of Agriculture may undertake to purchase all the seed provided that the proprietor guarantees purchasers among his tenants at the price paid to the seed farmer by the Department of Agriculture. The matter should not end there entirely. The private farms should be carried on for each crop so that if a proprietor notices any deterioration in the quality or sample of the paddy from his estate, he can make a re-issue of seed to those cultivators who used it.

TREATMENT OF SEED PADDY BEFORE SOWING IN THE NURSERY.

Circular III.

Farmers have complained that seed from the Department of Agriculture rotted before it germinated, but it was found that this was due to the fact that it was not always prepared for sowing in the best way.

The seed which is being issued this crop has been tested and gave 92% germination.

Allow 40 lbs. of seed per acre to be used. Previous to sowing in the nursery, take the seed in a half bag—not more—though a smaller quantity can be treated if desired and soak this in water for a night. The easiest way to do this is to put half a bag in a sweet water trench. Leave it in the trench for about 12 hours, or until all the paddy is thoroughly soaked,

When all the grains are thoroughly soaked, then take the seed out of the water and place it on some trash or rice straw and cover it with more rice straw and trash thickly. This generates heat in the bag of seed and it 'sprouts' very strongly.

Examine the bag after it has been under the "trash" heap for 12 hours and see how it is germinating. It will probably have to remain covered for 24 hours by which time all seeds should have germinated.

The seed may then be taken out of the bag and sown on to a well puddled nursery.

It will be found that this is a better method of setting a nursery than spreading the seed in the nursery, flooding and then running off the water. This latter method causes seed to rot, especially where germination is a little slow.

CENTRES* WHERE PRIVATE SEED FARMS HAVE BEEN ESTABLISHED, ESSEQUIBO COAST.

Spring Garden No. 1	Spring Garden No. 2	Good Intent
Aurora	Dryshore	Hibernia
Vilvoorden	H. I. Dieren	Pomona
Riverstown	Johanna Cecilia	• Zorg
Perseverance-Zorg-en-Lyght	Waste lands—Bremen	Cullen
L'Union	Affiance	Aberdeen
Land of Plenty	Mainstay	Reliance
Lima	La Belle Alliance	Coffee Grove
Windsor Castle	Better Success	Better Hope
Pomeroon River	Anna Regina	Bush Lot
Henrietta	Richmond	Pomeroon New Road

CENTRES* ESTABLISHED ON WAKENAAM ISLAND.

Maria's Pleasure
Zeelandia
Marionville
Good Success
Palmyra
Noitgedacht.

* Unfortunately it has not been possible to publish the maps, showing the situation of these centres, with this article.

THE BREEDING AND SELECTION OF CANE SEEDLINGS, WITH SPECIAL REFERENCE TO D. 625.

BY

C. HOLMAN B. WILLIAMS, Dip. Agr. (I.C.T.A.),

Sugar Cane Agronomist, Department of Agriculture, British Guiana.

The rediscovery of the fertility of cane seed was made independently in Java and Barbados about 1888. Harrison was working in Barbados at the time and became closely associated with Bovell in the work of cane breeding and selection which the latter initiated.

Jenman reported in 1889[1] the introduction of 12 seedling canes from Barbados to British Guiana, and in the same year Harrison, who had just been transferred to this Colony, carried out, for the first time, the analyses of the canes from the plots in the Botanic Gardens, Jenman having started collecting and examining canes there since 1881.[2]

Francis, Jenman's first collaborator, who was responsible for the analyses during the first eight years of the work, died, and Harrison succeeded him in 1889. That year[1] Jenman procured about 100 seedlings from six different varieties of cane, and, backed by Harrison, he proposed that the size of the experimental plots be increased, that a small horse mill be used for grinding the experimental canes, and also that manurial trials be started. In 1890 a separate "Report on the Agricultural Work in the Botanical Gardens" was published by Jenman and Harrison in collaboration.

At the time Bourbon was the principal cane grown here and in other tropical countries, and these two workers continued the testing of introduced canes (both old named varieties and new seedlings) and those bred locally, with a view to finding some variety which would prove superior to the standard cane. However in their Report for 1891-1892 they review the results of the work since its inception, some ten years previously, and state:[1] "It is gratifying to find that the results of this series of experiments unmistakably point to the fact that the Bourbon is undoubtedly the best variety for cultivation having regard to the conditions of our soils, seasons and climate."

In 1892, D. 625 was bred from a cane known as Dyer, and the first analysis of its juice is given on page 38 of Harrison and Jenman's report for 1893-94-95. In this report (p. 22) the authors state: "We would strongly recommend to the planters of the Colony experiments over areas of a few acres with Nos. 95 and 78, at the same time deprecating attempts to replace the Bourbon on a wide scale with these varieties until their value has been clearly proved by experiments."

Jenman died in 1902, and the Report for the years 1896-1901 was prepared mainly by Harrison. By this time the soil had become "Bourbon-sick" and,

after 15 years as a standard with which new canes were compared, Bourbon was abandoned in favour of White Transparent, Harrison stating that in his opinion "The relationships of the varieties to the Bourbon growing under healthy conditions are very similar to those shown to the White Transparent."[4]

It may be mentioned here that between 1896 and 1902, Jenman and Harrison germinated 313,900 seedlings, basketed 75,500 and put 19,100 out in the fields.[5] A considerable number had also been raised between 1889 and 1896.

In 1901, 20 years after Jenman's start, Harrison felt that 22 varieties could be recommended "with any certainty as being canes worthy of the attention of the Planters of the Colony for careful experimental cultivation."[6] D.625 was among the number mentioned, but no special attention was drawn to it, although it had now been in existence for 9 years. In point of fact it occupied 8th place among the varieties other than Bourbon then being cultivated by Planters in the Colony over areas of more than one acre. This is shown by the following table[6] :—

Name or Number of Cane.	*Number of Estates.*	*Number of Acres.*
White Transparent	24	1889
D. 109	20	1727
D. 78	15	629
B. 147	19	599
D. 145	14	442
D. 95	9	335
D. 74	10	216
D. 625	11	79
and 14 others.		

It is interesting to note that at this time Harrison was already able to conclude from his experiments and observations that :[8]

1. The sucrose content of a seedling cannot be predicted from that of its parent, nor that of a seedling propagated by cuttings from the sucrose content of the original seedling clump, and that indeed, with few exceptions, the sucrose content of parent varieties appeared not to be transmitted to the actual seedlings or to the canes propagated from them by cuttings ;

2. Similar conclusions hold good with regard to the percentage of non-sugars present in the juice, the glucose content, glucose ratio and, in part at least, the quotient of purity, they being governed by the relative degree of maturity of the canes examined ;

3. The average size of the parent variety closely governs the average size of its offspring but this is not true of the individual cane from which the seed is taken.

By 1903, D. 625 was at the head of the mean yields from experiments on sugar estates, 12 experiments being reported on from a total of 40 acres. It was also first in 1902 and gave a mean of 2.745 tons commercial sugar per acre for the two seasons, the next best being Sealy with 2.285. Still cautious, however, Harrison, who more than once refers to the conflicting results furnished by the experi-

ments and the difficulty of correctly interpreting them, does not advise extensive planting of D. 625. He says: "It is not advisable to draw any wide-reaching deductions from these experiments. They, however, indicate that several varieties of sugar canes may be relied upon to give in British Guiana yields of sugar in quantities equal to or greater than those of the Bourbon, and that several of the varieties, for instance D. 109, D. 74 and D. 95 possess well-marked ratooning qualities."[10]

Experiments on 1,007 acres of D. 625 were reported on in the years 1905-06. In the comparative table the variety held second place being beaten by D. 2468, of which, however, there were only 45 acres under experiment. This cane gave 2.43 tons commercial sugar per acre as compared with 2.20 for D. 625, two other varieties yielding 2.18 and 2.17 tons, respectively. In the general means for the years 1901-1905, D. 625 shows up to better advantage, having given 2.46 tons sugar per acre as compared with 2.03 for D. 95. However, 11 factories reported its milling qualities as 'good', 4 as 'fair' and 20 as 'bad', while the fuel value of its bagasse was reported by 11 as 'good', 9 as 'fair' and 14 as 'bad'. Nevertheless its superiority was now becoming apparent, and, in 1906, 14 years after its creation, Harrison thus cautiously recommended the cane which is now our standard: "The experiments indicate that many varieties of sugar canes can be relied upon in British Guiana to give yields of sugar in quantities equal to or greater than those obtained from the Bourbon, and that several varieties, for instance D. 625, D 145 and D. 109, possess well marked ratooning qualities. These canes can be safely recommended to cane farmers for trial, the two former on relatively heavy lands, the latter on lighter soils."[11]

From 1906 on there was a gradual increase in the area planted to D. about one-third of each year's plantings being made to this variety between 1906 and 1912. The following table, copied from Harrison *et al*,[12] shows the acreages planted and the yields of commercial sugar per acre obtained from Bourbon, White Transparent, D. 109, D. 145 and D. 625 during the years 1902 to 1912.

	Bourbon		W. Transparent		D. 109		D. 145		D. 625	
Year	Acreage	Yield	Acreage	Yield	Acreage	Yield	Acreage	Yield	Acreage	Yield
1902	66,048	1.76	1,899	1.86	1,727	2.14	442	2.17	79	2.52
1903	63,675	1.86	2,786	1.64	2,583	2.09	644	1.88	191	2.66
1904	60,977	1.64	2,876	1.26	3,338	1.78	902	1.74	537	1.94
1905	56,137	1.61	1,796	1.41	5,491	1.88	1,316	1.92	1,445	2.20
1906	50,910	1.71	1,416	1.30	8,386	1.59	1,842	2.06	3,357	1.86
1907	45,626	1.53	1,043	1.40	11,184	1.56	2,403	1.72	6,600	1.72
1908	38,134	1.76	637	1.37	9,908	1.56	3,284	1.90	9,664	2.02
1909	30,324	1.79	572	1.39	6,896	1.59	3,710	1.91	13,564	2.11
1910	28,823	1.66	357	1.56	4,063	1.57	4,229	1.76	16,650	1.80
1911	24,252	1.57	251	1.37	3,261	1.48	4,382	1.73	21,672	1.73
1912	22,403		203		2,548		4,618		23,669	

While the above figures point to the fact that the planters gradually recognised D. 625 as being better than the rapidly failing Bourbon, they do not indicate that there was any sudden change over from one variety to another This is not surprising for when allowance is made for improvements in machinery, the introduction of mechanical tillage, the use of flood-fallowing and the great reduction in the loss due to Castnia, there is but little reason to suppose that D. 625 was markedly better than Bourbon when the latter was at its best. It seems to have been the case of a suitable substitute having been found to replace a rapidly failing standard cane, rather than a new "wonder" cane having been produced and displacing the standard cane by reason of its marked superiority thereto. And thus it is not until 1924 that we find 70 per cent. or more of the cane area in D. 625.

Of the many thousands of canes bred by Harrison before D. 625, and the still greater number bred by him since (during the years 1893 to 1919), none has definitely proved itself superior to the seedling of Dyer. However, it is only fair to say that the testing of Harrison's 1913, 1917, 1918, and 1919 canes, and those bred by the Sophia Experiment Station in 1920, 1921, 1922 and 1923, has been only partially carried out. A promising seedling can be multiplied so that a sufficient quantity is available for laying out one or more replicate trials about 4 years after its creation. In another three years results should be available for one complete cycle of Plant Cane, First Ratoon and Second Ratoon trials, and also from some Plant Cane and First Ratoon trials started later. At this stage, *i.e.*, seven years after its creation, the experimenter should form a reasonably correct opinion as to the value of the variety and be able to recommend its *trial* on a commercial scale by planters. In this connection it is interesting to note the views held by Harrison and Jenman on this point. As early as 1892 they state: "We have arrived at the conclusions that a period of three crops is sufficient to form a fair opinion upon the probable value of any variety of sugar cane and that a period of from five to seven crops is necessary to ascertain with approximate accuracy the relative values of different varieties."[9] On this basis, it should now be possible to advise commercial trials with any canes bred previous to 1924, but, unfortunately, there have been several changes in the administration of the British Guiana Sugar Planters' Experiment Station, on which, since 1920, has devolved the breeding and comparison of canes. The testing has not been regularly and systematically carried out, and has not kept pace with the breeding. In consequence there is an undue accumulation of untested canes which have shown up well in preliminary trials, among which there are probably a few equal to D. 625 and possibly a couple that are definitely better, but on which, for lack of definite figures, no pronouncement can be made. Replicated tests have now been started with most of the canes bred before 1920 and some figures for the plant canes are already available. In addition, a large number of the 1920, '21 and '22 canes (Sophia seedlings) are now being tested for the first time and it is hoped that some of these will prove of value.

In this connection, one sometimes hears complaints about the juice of new seedlings. The variety tests reaped this year revealed quite a few seedlings with juice as rich or richer than that of D. 625, and some of those which gave apparently inferior juices were, to judge by the figure for glucose ratio, immature. It is well to recall here that Harrison at first considered[7] that D. 625 could not mature under local conditions, but later stated[13] that "With certain varieties, for instance D. 625, the lessening vigour of their growth has been attended by increases in the saccharine-content, and in the quotient of purity of their juices," following the statement by figures in its support.

The search for new and better varieties of cane is a long and costly task. Only once in history has such an outstandingly better variety appeared that, as happened with P.O.J. 2878 in Java, planters unanimously and rapidly adopted it (12.5% of the 1925 plantings, 66% of the 1928, 93% of the 1929). What is more usual is the discovery of a D. 625 which gradually and laboriously climbs to the head of the list, an H. 109 which 12 years ago covered 4% and now only forms 44.6 % of the Hawaiian plantings, an E.K. 28 which took seven years to climb from 4% of Java's plantings to 45.75 %. Java sugar producers contribute about $1.26 per acre for the support of an experiment station which spends $480,000 per annum and has a staff of 166. After nearly 40 years of steady work, P.O.J. 2878 was evolved. Hawaiian planters have supported a station for over 30 years. They pay about $0.48 per ton of sugar, or $290,000 per annum, to maintain it. No outstanding Hawaiian variety has gone into cultivation since H.109, which covers 44.6 per cent. of the cane lands and is now officially stated to have probably "reached its maximum area." (In Hawaii D. 1135 covers 42,394 acres, is third in order of area planted, and is being gradually extended every year. Louisiana depended for many years on Demerara canes.) Cane breeding and experimental work of a high standard have been in progress in Barbados for 43 years. It has been said that the work with cane involves $50,000 of the Department of Agriculture's annual expenditure of $75,000. Some 650,000 seedlings have been bred and 260,000 transplanted to the field; no outstanding and truly satisfactory cane has appeared since B. H. 10 (12), reared 21 years ago and Ba. 11569 bred in 1911, and less than a dozen varieties have ever been commercially cultivated. In British Guiana the expenditure on cane research does not exceed $20,000 per annum, funds being raised by a cess of $0.25 levied on each acre of cane in the colony.

Some idea of the difficulties of the production of improved canes will be gathered from the fact that after 40 years of unremitting labour in the major sugar producing countries of the world, only a single "wonder" cane, P. O. J. 2878, has been bred, and less than a score of other outstanding varieties have been discovered, albeit these have, in several instances, been responsible for the survival of the industry. It is greatly to the credit of Harrison and Jenman that, with limited facilities, they were able to contribute D.625 to the latter group.

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10. Progress Report on the Sugar Cane Experiments for the year ended 30th June, 1903, pp. 1-3 (Extract from *The Official Gazette* of 25th November, 1903).
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13. *Ibid.*, p. 181.

A FIELD TRIAL OF PADDY VARIETIES AT THE EXPERIMENTAL STATION, EAST DEMERARA, 1931.

BY

E. M. PETERKIN,

Agricultural Superintendent, Department of Agriculture, British Guiana,

AND

R. R. FOLLETT-SMITH, B.Sc., A.R.C.S.,

Chemist-Ecologist, Department of Agriculture, British Guiana,

During the year 1930 a field trial, with twelve varieties of paddy, was carried out at the Experiment Station, Georgetown. The results are contained in the Administration Report of the Director of Agriculture for the year 1930 (page 46).

Only the six heaviest yielders of the 1930 experiment were retained for trial in 1931. The varieties used in this experiment were :—

Demerara Creole	...	an old established variety.
Blue Stick	...	,, ,, ,, ,,
No. 75	...	,, ,, ,, ,, local selection.
No. 75	...	a local selection.
No. 79	...	,, ,, ,,
H. 7	...	an old established variety, local selection.

The trial was laid out in the form of three, five by five, latin squares. Each plot had an area of 1/80th acre and was surrounded by a strip of the same variety which was subsequently discarded to eliminate border effect.

The nurseries were sown on the 1st June, the seedlings were transplanted on the 6th July and the plots were reaped on the 26th—30th October. The rainfall for this period and the mean monthly rainfall for the last ten years are appended :—

Monthly Rainfall at the Experiment Station, Georgetown.

	...	1931	...	Mean 1921-1930
June	...	11.12	...	13.37 inches
July	...	12.23	...	9.64 ,,
August	...	6.19	...	7.11 ,,
September	...	4.19	...	3.05 ,,
October	...	5.68	...	3.24 ,,

The rainfall during the early part of the growing season was normal. It was slightly above the average during the latter part of the crop period.

The yield of paddy obtained from each variety in bags of 140 lbs. per acre is shown in the following table. The varieties are placed in order of merit and the results are also stated as percentages of the general mean. The results of the 1930 trial are included for comparison:

Variety	Bags paddy (140 lbs.) per acre 1931.	Per cent. 1931	Bags paddy (140 lbs.) per acre 1930
No. 79.	24.41	113.6	23.94
H. 7.	22.97	106.9	24.94
Demerara Creole	22.57	105.0	22.00
No. 76.	21.77	101.3	22.24
No. 75.	20.77	96.6	22.11
Blue Stick	16.54	76.9	20.95
Standard Error	0.417	1.94	0.54
Mean of all plots	21.50	100.0	...

In this experiment No. 79 gives a definitely better yield than the other varieties tested. No differences between the yields of H. 7, Demerara Creole and No. 76 are apparent.

No. 75 gives a lower yield than H. 7 or Demerara Creole. Blue Stick gives a lower yield than the other varieties. In this connection it should be noted that the latter variety suffered from a leaf disease during the experiment.

In the 1930 trial H. 7 and No. 79 were superior to the other varieties but no difference between their yields was noted. The varieties No. 76, No. 75, Demerara Creole and Blue Stick all gave similar yields.

A comparison of the yields of the three latin squares, in bags of paddy per acre and as a percentage of the general mean, is appended.

Square	A	B	C	Standard Error
Bags paddy (140 lbs.) per acre	21.6	22.5	20.0	0.295
Per cent.	100.4	104.8	93.0	1.37

Square B gives more paddy than squares A and C. Square A gives a higher yield than square C. These differences in yield may be explained by the facts

that square C is, to some extent, shaded by a neighbouring belt of bamboos. and that square A has been longer in cultivation than has square B.

The order of merit of the varieties in the separate squares shows no definite signs of alteration, i.e., the different growth conditions of the three squares makes no difference to the relative yields of the different varieties.

Milling tests on 100 lb. samples of each variety were carried out by Mr. Ramnarine Pundit at his rice mill in Albouystown. The samples of rice were subsequently examined by the Grading Inspector. The results are as follows:

Variety	Clean rice per cent. of paddy	Percentage of broken & dis-coloured grains	Colour	Remarks
No. 79	68.5	7.0	Whole grain super.	Super. No. white grains.
H. 7	68.0	23.6	do.	No. 1. Fair number of white grains.
Demerara Creole	68.0	18.9	do.	No. 1. Few white grains.
No. 76	64.0	16.8	do.	No. 1. Few white grains.
No. 75	67.0	19.0	do.	No. 1. Few white grains.
Blue Stick	65.0	9.3	do.	Super Fair number of white grains.

From the results of trials over a period of two years it would seem that variety No. 79 is to be preferred where the production of Super rice is desired and that varieties H. 7 and Demerara Creole are the heaviest yielders of No. 1 Rice under present milling conditions. The rice milled from variety No. 79 is very similar to that obtained from Blue Stick. The former may possibly replace the latter which not only lodges badly but shatters very easily.

VARIETY EXPERIMENTS WITH SUGAR CANE: 1.

BY

C. HOLMAN B. WILLIAMS, Dip. Agr. (I.C.T.A.),

Sugar Cane Agronomist, Department of Agriculture, British Guiana.

INTRODUCTION.

For a number of years now the sugar industry of British Guiana has depended almost entirely on the variety D. 625. Such a situation is not without its drawbacks, for, quite apart from the probability that a higher yielding cane can be found, there is a grave danger in a country committing itself to a single variety and not maintaining a satisfactory substitute or substitutes to which the industry can turn should the standard cane suddenly fail through disease or some other cause—an occurrence by no means unknown in the history of cane sugar production.

D. 625 was bred by Harrison and Jenman in 1892 from an arrow of a cane known as Dyer. It was not a phenomenal success at the start and appears to have only attracted moderate attention, for after 10 years only 79 acres were in cultivation and Harrison stated that it did not appear to mature under local conditions. Reports on its milling qualities, too, were not very encouraging. By 1904 there were 1445 acres of D. 625, but there were three other canes planted to a similar extent, and the area planted to D. 109 was three times as great. However the quality of the D. 625 juice improved gradually, and eventually the cane reached its present foremost position.

Harrison continued his breeding and selection until 1919, but none of his canes was able to displace the seedling from Dyer bred in 1892.

In December 1920 the work of cane breeding was transferred to the British Guiana Sugar Planters' Experiment Station which has produced a very large number of seedlings since then. Unfortunately there have been several changes in the administration of the Station and steady and adequate testing of the varieties produced has not been maintained. In consequence there has been an accumulation of partially tested canes, and when the writer assumed charge of the Station in May 1929 he found, in addition to small patches of a large number of varieties dating from 1920 onwards, a goodly number of Harrison's varieties bred in 1913, 1917 and 1918, of which all that can be said is that they had given too promising

results in preliminary tests to permit of their being discarded, and yet were not sufficiently proven to justify their being recommended to planters.

Since a new breeding programme was being instituted and all attention would soon be taken up by new seedlings, it seemed advisable to lay down a number of variety trials to enable a definite pronouncement to be made on these older varieties so that they might either be recommended or definitely discarded.

A new departure was made in establishing these trials not only at the Sophia Experiment Station, but also scattered over the Colony, on certain sugar estates. The experiments were laid down in conformity with modern standards for field trials, and certain introduced canes, with good reputations abroad, were also included to determine their worth under local conditions. In response to a special request, Bourbon was included in two trials to verify whether it would "come back" after the land had been rested from it for all these years and especially after flood-fallowing, a practice that did not obtain when Bourbon failed.

The results from the plant canes of these tests are now presented.

The Experiments.

The trials reaped this season include two plant cane and one first ratoon at Sophia, and plant cane experiments at Uitvlugt, Diamond, Lusignan, Blairmont and Port Mourant. The type of lay-out and number of replicates are indicated below:

Sophia, 17 W.,	Latin Square,	5	replicates,	Plant Canes
" 13 E.,	Randomized blocks,	5	"	" "
" 13 W.,	" "	10	"	1st Ratoons
Uitvlugt, 1 W.,	"	4	"	Plant Canes
Diamond, 53 G.D.,	"	6	"	" "
Lusignan, 19 E.,	"	5	"	" "
Blairmont, 11 R.,	"	5	"	" "
Port Mourant, 6 R.,		5	"	" "

The rainfall registered at the various stations during the experimental period and the normal monthly averages are compared in Table I.

It will be seen that the total precipitation was about normal at Diamond, Lusignan and Blairmont, well below normal at Uitvlugt and Sophia, and above normal at Port Mourant. There was a period of drought lasting from August 1930 to April 1931 at Sophia, Uitvlugt, Diamond and Lusignan. Dry weather during the first half of this period also made itself distinctly felt at Port Mourant and Blairmont. The effect of the adverse weather conditions was obvious, in some instances, even when the canes were reaped.

TABLE I.

RAINFALL DURING EXPERIMENTAL PERIOD AT SOPHIA AND SUB-STATION

ESTATE :	Port Mourant		Uitulugt		Diamond		Lusiguan		Sophia		Blairmont	
Experiment Started	May 1930.		June 1930		May 1930		June 1930		June 1930		June 1930	
Experiment reaped :	September 1931		September 1931		September 1931		October 1931		September 1931		October 1931	
MONTHS	Rainfall 1930-31, inches	Average-Rainfall 1911-30, inches	Rainfall 1930-31, inches	Average Rainfall 1916-30, inches	Rainfall 1930-31, inches	Average Rainfall 1911-30 inches	Rainfall 1930-31, inches	Average Rainfall 1917-30, inches	Rainfall 1930-31, inches	Average Rainfall 1921-1930 inches,	Rainfall 1930-31 inches,	Average Rainfall 1911-30, inches
May	8.91	8.33			12 20	14.12						
June	10.91	9.10	12.97	13.96	16 32	14.03	15.93	12.93	12.96	14.86	10.83	12.29
July	16.86	8.81	22.67	11.91	23 22	11.59	18.81	9.39	22.76	10.98	18.36	10.44
August	6.06	4.83	5.68	8.12	6.02	8.13	4.58	5.90	6.16	8 50	2.49	6.58
September	.60	1.95	2.93	3.53	1.89	3.79	1.07	2.30	.99	3.07	1.06	2.08
October	.35	2.57	1.39	3.77	1.78	3.94	.86	2.96	1.37	3.64	.15	2.58
November	14	3.38	2.49	7.95	1.78	6.35	.70	5.59	1.60	6.68	.56	3.69
December	4.77	8.07	9.59	13.87	8.44	12.51	7.55	11.24	8.94	14.78	6.33	9.65
January	7.96	6.91	4.55	9.02	3.15	9,21	3.92	8.77	2.13	7.61	10.00	8.95
February	6.76	4.61	6.02	3.98	3 48	5 21	3.66	4.17	3.58	3.76	9 42	4.63
March	2.87	3.35	1.19	4.60	2.53	5.18	2.00	3.88	2.17	3.89	2.67	4.42
April	2.88	4.43	1.44	5.14	2.17	5.57	1.19	4.68	1.23	4.41	6.13	5.14
May	20.14	8.33	13.47	13.63	13.80	14.12	13.44	11.19	11.66	11.67	15.34	10.27
June	11.51	9.10	14.16	13.96	15.83	14.03	13.23	12.93	12.59	14.86	11.97	12.29
July	11.05	8.81	14.90	11.91	19.79	11.59	14.86	9.39	12.76	10.98	8.85	10.44
August	1.82	4.83	5.81	8.12	6.36	8.13	8.33	5.90	6.97	8.50	3.02	6 58
September	2.82	1.95	5 28	3.53	6.50	3.79	3.68	2.30	3.06	3.07	5.43	2.08
October							6.87	2.96			2.62	2.58
TOTAL	116.41	99.36	124.54	137.00	145.26	151.29	120.68	116.48	110.96	131.26	115.23	114,69

The experimental fields at Uitvlugt, Diamond, Lusignan, Blairmont and Port Mourant were all flood-fallowed previous to planting. That at Blairmont had been tractor-ploughed before it was flooded. At Sophia the fields were all hand-prepared, and none of them was flood-fallowed. Normal estate cultivation and manuring were given to all the experiments.

Except in one instance, each plot consisted of 15 rows of cane across one bed Two of these were discarded as "buffers" at the time of reaping, and the canes from 13 rows (0.06 acre) weighed on the spot. In the case of 13 W., Sophia, the plots consisted of seven rows each, of which five (0.02 acre) were weighed. A fifty pound sample of cane from each plot was sent to Sophia, ground in the experimental mills, and the juice analysed. The bagasse from each sample was also analysed after it had been disintegrated in a Wiley mill. In consequence it was possible to obtain the true figure for sucrose in cane.

The Results

Table II.

Estate:	Sophia		Sophia		Sophia		Blairmont	
Field:	17 West		13 East		13 West		R. 11	
Age of Cycle:	Plants		Plants		1st Ratoons		Plants	
Age of Canes:	15.75 Months		15.5 Months		15.0 Months		18.75 Months	
Soil	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil
	Markedly acid fine Silt	Markedly acid fine Silt	Acid fine Silt	Neutral fine Silt	Markedly acid heavy Silt	Acid Clay	Markedly acid Clay	Markedly acid Clay
Normal pH:	5.30	5.05	5.73	6.50	5.17	6.10	5.52	4.73
Exchange pH:	5.00	4.45	5.43	6.00	4.67	5.38	5.40	4.88
Lime Requirement, tons:	4.80	5.20	3.90	1.50	6.10	3.50	4.86	4.33
Organic Matter, %:	1.24		1.08	0.48	1.62	0.60	1.18	0.80
Index of Texture:	32	38	32	30	43	49	46	47

Mean Yields:

Sophia, 17 West

Variety	Cane per Acre (tons)	Sucrose in Cane (%)	Glucose Ratio	Sucrose in Cane per Acre (tons)
D.625	26.90	11.93	7.41	3.18
D.666/18	26.29	11.75	6.32	3.08
D.73/20	21.78	12.99	3.72	2.82
S.C. 12 (4)	21.17	12.07	3.19	2.55
B.H.10(12)	18.20	12.59	5.04	2.29

Sophia, 13 East

Variety	Cane per Acre (tons)	Sucrose in Cane (%)	Glucose Ratio	Sucrose in Cane per Acre (tons)
D.625	22.52	13.21	6.45	2.99
D.835/18	22.79	12.85	5.41	2.93
D.695/13	22.66	12.69	8.97	2.87
D.351/20	20.57	13.28	4.07	2.71
P.O.J.2727	22.78	11.89	5.14	2.71
P.O.J.2725	21.31	12.35	3.66	2.63
D.557/20	21.66	11.83	4.36	2.56
D.689/13	21.49	11.74	8.40	2.51
B.H.10(12)	17.51	13.16	3.42	2.43
S.C.12(4)	19.55	12.17	3.19	2.38

Sophia, 13 West

Variety	Cane per Acre (tons)	Sucrose in Cane (%)	Glucose Ratio	Sucrose in Cane per Acre (tons)
D.625	21.04	12.99	6.07	2.73
D.695/13	19.68	13.10	3.66	2.55
P.O.J.2727	20.16	12.00	3.46	2.42
P.O.J.2725	18.24	12.73	3.50	2.34
D.689/13	19.40	11.69	7.07	2.24
D.557/20	17.34	11.80	3.60	2.06
D.835/18	14.73	12.62	5.69	1.85
D.351/20	13.60	13.57	4.24	1.84
S.C. 12(4)	14.60	12.29	2.54	1.79
B.H.10(12)	12.51	13.56	2.86	1.70

Blairmont, R. 11

Variety	Cane per Acre (tons)	Sucrose in Cane (%)	Glucose Ratio	Sucrose in Cane per Acre (tons)
◇ 10	43.30	15.92	4.77	6.88
D.835/18	48.01	13.36	5.90	6.41
D.663/13	47.84	12.30	6.05	5.88
D.666/18	46.66	12.47	8.44	5.81
D.814/12	45.46	12.71	6.01	5.78
D.625	42.83	13.27	8.25	5.68
D.694/21	50.65	10.86	15.70	5.57
B.H.10(12)	34.18	14.50	3.65	4.96
S.C.12(4)	37.04	12.96	3.57	4.80
Bourbon	30.52	12.76	7.22	3.88

	Sophia, 17 West	Sophia, 13 East	Sophia, 13 West	Blairmont, R. 11
Significant difference, 20 to 1: ...	0.34 ton Sucrose per acre	0.60 ton Sucrose per acre	0.47 ton Sucrose per acre	1.23 ton Sucrose per acre
Canes significantly better than D. 625:	... ...	... ...	... ...	Diamond 10
Canes not differing significantly from D. 625: ...	D. 666	D. 835, 695, 351, 557, 689, P.O.J. 2727, 2725, B.H.10(12)	D. 695, P.O.J. 2727, 2725	D.835, 666, 694, B.H.10(12), S.C.(12), D. 663

TABLE II. (*Contd.*)

ESTATE:	Port Mourant		Uitvlugt		Diamond		Lusignan	
Field:	R. 6		1 West		G.D. 53		19 East	
Age of Cycle:	Plants		Plants		Plants		Plants	
Age of Canes:	16.75 Months		15.5 Months		16.75 Months		16.25 Months	
Soil	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil
	Markedly acid Clay	Slightly acid Clay	Markedly acid heavy Silt	Markedly acid heavy Silt	Highly acid Clay	Highly acid Clay	Markedly acid heavy Silt	Markedly acid heavy Silt
Normal pH:	5.76	6.63	5.30	5.93	4.67	4.75	5.52	5.40
Exchange pH:	4.67	6.07	4.08	4.88	3.73	3.77	4.73	4.85
Lime Requirement, tons:	5.69	1.95	6.38	3.50	14.50	14.20	6.66	4.27
Organic Matter, %:	2.12	0.73	1.11	0.63	1.87	1.57	1.90	0.65
Index of Texture:	50	48	41	45	48		46	47

Mean Yields:

Port Mourant

Variety	Cane per Acre (tons)	Sucrose in Cane (%)	Glucose Ratio	Sucrose in Cane per Acre (tons)
D. 625	40.63	13.55	7.0	5.51
D. 835/18	36.56	13.99	5.4	5.10
D. 73/20	31.94	13.92	4.2	4.46
D. 666/18	36.82	12.10	8.4	4.45
B.H.10(12)	34.33	12.70	5.2	4.37
S.C. 12 (4)	32.84	12.70	3.5	4.17

Uitvlugt

Variety	Cane per Acre (tons)	Sucrose in Cane (%)	Glucose Ratio	Sucrose in Cane per Acre (tons)
D.625	33.75	12.97	8.31	4.37
D.666/18	32.60	12.94	5.80	4.21
S.C. 12(4)	28.83	12.51	4.00	3.62
B.H 10(12)	27.42	12.96	5.17	3.55
D.835/18	28.79	11.88	9.30	3.41
D.205/20	25.16	12.42	9.73	3.09
Bourbon	21.83	11.79	11.80	2.57

Diamond

Variety	Cane per Acre (tons)	Sucrose in Cane (%)	Glucose Ratio	Sucrose in Cane per Acre (tons)
<> 10	33.19	14.17	4.06	4.70
D.557/20	31.25	12.43	5.54	3.88
D.625	32.91	11.75	13.89	3.86
<> 17	32.63	11.81	11.51	3.84
S.C. 12(4)	28.66	11.98	6.40	3.43
D.666/18	29.98	10.95	17.13	3.26
D.628/20	23.47	12.89	5.59	3.02
D.835/18	24.96	12.07	9.06	3.01
D.351/20	22.36	13.06	6.42	2.91
D.73/20	21.52	13.11	6.80	2.82

Lusignan

Variety	Cane per Acre (tons)	Sucrose in Cane (%)	Glucose Ratio	Sucrose in Cane per Acre (tons)
D.351/20	35.70	13.12	8.49	4.69
D.447/17	30.65	14.06	8.02	4.30
D.666/18	36.35	11.79	9.26	4.27
D.31/17	27.53	13.48	9.37	3.71
B.H.10(12)	26.06	13.44	6.37	3.51
D.625	29.06	11.95	11.23	3.46
S.C.12(4)	27.09	12.10	4.38	3.28

	Port Mourant	Uitvlugt	Diamond	Lusignan
Significant difference, 20 to 1: ...	0.78 ton Sucrose per acre	0.76 ton Sucrose per acre	0.42 ton Sucrose per acre.	0.75 ton Sucrose per acre.
Canes significantly better than D. 625: ...	... ...	... ...	Diamond 10.	D.351/20, 447/17, 666/18.
Canes not differing significantly from D. 625: ...	D. 835/18	D. 666/18, S.C. 12 (4)	D.557/20, Diamond 17.	D.31/17, B.H. 10(12), S.C. 12(4)

TABLE III.

SUMMARY OF RESULTS FROM ALL EXPERIMENTS.

VARIETY	No. of Plots and Analyses considered	No. of Experi-ments considered	GENERAL MEANS FOR Cane per Acre, tons	Extrac-tion, %	Sucrose in Cane, %	Glucose Ratio	Purity	Sucrose in Cane, per Acre, tons.
D. 663/13	5	1	47.84	60.20	12.30	6.85	82.8	5.88
Diamond 10	11	2	38.24	61.73	15.04	4.42	88.7	5.79
D. 814/12	5	1	45.46	59.80	12.71	6.01	85.0	5.76
D. 684/21	5	1	50.65	60.20	10.66	15.70	75.0	5.37
D. 447/17	5	1	30.65	59.60	14.03	8.02	87 2	4.29
D 666/18	30	6	34.77	61.73	12.00	9.19	83.0	4.18
D. 625	45	8	31.21	61.21	12 70	8.57	84.4	3.96
Diamond 17	6	1	32.63	58.08	11.81	11.51	83.0	3.84
D. 835/18	35	6	29.31	62.72	12.79	6.68	85.7	3.78
D. 31/17	5	1	27.53	55 30	13.38	9.37	84.2	3.71
D. 73/20	16	3	25.07	61.80	13.34	4.91	87.2	3.57
B. H. 10(12)	39	7	24.32	58.21	13.36	4.53	88.1	3.28
S. C. 12(4)	45	8	26.22	57.88	12.35	8.84	86.7	3.25
Bourbon	9	2	26.17	62.48	12.27	9.55	83.4	3 22
D. 203/20	4	1	25.16	63 25	12.42	9.78	84.5	3.09
D. 351/20	26	4	23.06	60.12	13.26	5.05	87.3	3.04
D. 628/20	6	1	23.47	59.50	12.89	5.59	87.9	3.02
D. 557/20	21	3	23 42	58.69	12.02	4.50	86.0	2.83
D 695/13	15	2	21.17	57.62	12.89	6.31	87.0	2.71
P O.J. 2727	15	2	21.47	55.85	11.94	4.30	84.8	2.56
P.O.J. 2725	15	2	19.77	56.62	12.54	3.58	86.7	2.48
D. 689/13	15	2	20.44	62.41	11.71	7.73	83.0	2.37

DISCUSSION.

The general average of tons cane per acre for all plots was 28.13 with a mean sucrose content of 12.69 per cent. The sucrose in cane is 2.44 per cent. higher than the average figure (10.25) for the cane crushed in the factories of the Colony during the same period. The difference is possibly due to transport delays between field and factory in commercial practice (all experimental samples were crushed about 24 hours after cutting), and it is proposed to investigate the matter further in order to settle the point. On the other hand 12.69 per cent. sucrose in cane is not a very high figure, for Natal cane (all Uba yielding about 20 tons cane per acre) contained 13.66 per cent. sucrose in 1930, Java cane (93 per cent. P. O. J. 2878) 13.40, and Ste. Madeleine (Trinidad) cane (33 per cent. Uba, 66 per cent. B. H. 10 (12), &c.) 12.61 per cent. in 1931.

The mean yield of sucrose in cane per acre for all the plots was 3.57 tons and the mean glucose ratio 6.45. Apparently some of the canes were reaped when they were immature, and it is not unreasonable to assume that the yields of D. 684/21, D. 666/18, D. 625. D. 447/17, Diamond 17, and D. 31/17 would have been

higher had they been reaped at the correct time. All of these seedlings, however, except the last two, gave higher cane yields than D. 625, so that their relative positions with respect to the latter would not have been changed, nor indeed would that of 31/17 have been changed as the sucrose content of this cane was distinctly higher than that of D. 625. On the other hand canes like B.H. 10 (12), S.C. 12 (4), Diamond 10, P.O.J. 2725 and P.O.J. 2727 were probably quite ripe when reaped.

CONCLUSIONS.

It would be unwise to draw any definite conclusions from the plant cane results. Further trials with the best of the varieties reaped this year, and numerous new ones, have been laid down. The plant cane results from these trials will be available at about the 'same time as the first ratoon figures for the trials here reported. With the data then available it should be possible to be much more definite. For the present the general *indications* are that :

(a) D. 625 is still a satisfactory yielder.

(b) Diamond 10, D. 663/13, D. 814/12, D. 684/21, D. 447/17, D. 666/18, D. 835/18 and D. 351/20 are possible rivals of D. 625, and if not definitely better, some of them would, at any rate, be useful substitutes if the standard cane should deteriorate (this is especially true of D. 835/18 and D. 666/18 which were tried in several experiments and Diamond 10 which is reported to have given satisfactory results on a commercial scale) ;

(c) There is nothing to be gained by including B.H. 10 (12), S.C. 12 (4) Bourbon, D. 689/13, D. 73/20, D. 628/20, P.O.J. 2725, P.O.J. 2727, and D. 203/20 in new trials.

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DISTRICT NOTES.

EAST DEMERARA.

The ten-acre block of pure line Demerara Creole paddy at Pln. Nonpareil has made satisfactory growth; roguing has been started. Reaping will take place about the end of October. Four half-acre blocks have been discarded as they are badly mixed.

The building of the bond for storing this padi has been started.

Rice Competitions.

Lower East Coast.—This is progressing favourably. The competitors at Belfield are not evincing the same interest as at Nonpareil. All of the blocks are in full flower. The value of these competitions is shown at Pln. Hope where the entire estate—nearly 900 acres—is under pure line Demerara Creole.

Mahaica-Mahaicony. (Sophia's Hope) The competitors here have had to withdraw; owing to a shortage of water during the flowering period very little grain set properly; the entire area affected has a scorched appearance. This is very unfortunate as this estate in 1930 won the 1st, 2nd, and 3rd prizes and displayed considerable interest in the present competition. The effects of the 1930 Competition is very marked over the entire estate in the purity of the standing rice. The plots at Drill are the most promising.

4 H Club, Beterverwagting.—This site was planted with Blackeye peas intended to serve the double purpose of a cover as well as an edible crop. After this was taken off the land was forked into beds and allotted. A nursery has been started with vegetable seeds supplied by this Department. Tools were also supplied. The Agricultural Instructor of the district visits twice weekly giving advice and supervision. The boys are gradually settling down to work, but there is still a lot of uphill work ahead.

Lodge Village Allotments.—There are 59 people on allotments. A few of the earlier farmers have either abandoned or had their beds taken away; these beds have been given to others on the waiting list. The majority are doing fairly well, and a few very well indeed. The Ex-service men are taking great interest, and are working well. On the whole progress is satisfactory.

Quantities of seeds and seedlings, cuttings, banana and plantain suckers have been distributed free.

Sub-Station Cecilia.—No change. It is intended, however, at the end of the year, to lay out plots of all the varieties of sweet potatoes obtainable for observation purposes; also to lay out nurseries of onions, &c, for distribution of seedlings.

The Agricultural Instructor has spent much time in supervision of the Rice Competitions and pure lime seed areas, besides his regular instructional work.

Co-operative Credit Banks.—The usual meetings have been held, and every effort has been made to collect outstanding loans.

E. M. PETERKIN,
Agricultural Superintendent,
East Demerara.

WEST DEMERARA.

Sugar.—In September the Varietal Trial carried out at Pln. Uitvlugt was reaped, and the necessary data collected and samples taken.

The paddy competitions and pure seed supply plots continued to demand a considerable portion of the District Officer's time and attention. The nurseries at Windsor Forest and at Blankenburg were satisfactorily established. Although some damage was done by the rice caterpillar (*Laphygma frugiperda*), the injury to these nurseries from the pest was conparatively light.

The insistence of sparse distribution of the seed in the nurseries resulted in quick growing and vigorous seedlings. This served as a useful demonstration on the relation of large nursery space to earlier transplanting of the seedlings to the field.

On the whole the nurseries were better prepared and the fields more thoroughly ploughed in readiness for transplanting in the Windsor Forest than those in the Blankenburg plots.

Good, even growth was made and weather conditions in the district were particularly favourable to vigorous vegetative growth, provided the land was prepared and seed sown early enough.

Tobacco Trials.—Attempts were made to establish a number of half acre blocks of tobacco in the Canals Polder area. It was intended that the cultural operations should be carried out by resident farmers according to the instructions of the Agricultural Department which would give some financial aid to the farmer-owner of each plot. The objects of this were both to ascertain definitely what growth was made on those soil types and to provide practical demonstration of the routine operations connected with tobacco culture. The results in the nursery stages were disappointing mainly because there was a dry spell soon after sowing, and, along the Canals, there is no water which can be used for irrigation since all water in the trenches is "sour." Another factor which operated adversely is that the farmers are not accustomed to cultivate crops which demand the regular attention required by tobacco.

Coffee.—The routine extension duties were performed and visits paid to a number of coffee farms. On account, however, of the low prices prevailing there is little effort being made by the average farmer to improve his cultivation.

Co-operative Credit Banks.—Regular monthly meetings of the Committees of Management of the six Banks in the district were held. The condition of the Banks at Den Amstel and Leguan is such as to demand a very firm line of action being taken and, at these Banks, the granting of loans has been reduced to a minimum; vigorous efforts have been made to increase collections. The other four Banks, although affected by the general depression, are giving no cause for immediate concern.

Competitions.—Throughout the nursery and planting stages the rice entered in the Department's Competitions was watched and marks awarded.

Exhibitions.—Having been appointed to assist in the organisation of the Department's Stand at the Centenary Exhibition the Superintendent devoted much time to this work during September.

The Agricultural Superintendent returned from the N. W. D. at the end of August and took over the work of the district from Mr. H. D. Huggins.

J. D. GILLESPIE,
Agricultural Superintendent,
West Demerara.

BERBICE.

Frequent visits were paid to Plns. Port Mourant and Blairmont in connection with six sugar cane trials in progress there. At the former estate, a varietal trial was reaped in September in collaboration with the Cane Agronomist. Plns. Rosehall and Lochaber were visited in July and Albion in August.

The two blocks of Pure Line Demerara Creole paddy installed on Plns. Port Mourant and Rosehall by courtesy of the Managers were transplanted in July. These crops when reaped will be stored at Whim and New Amsterdam for distribution to seed farmers throughout the district.

Of the two rice competitions started, the one at No. 70-72 Corentyne was most unfortunate. Out of 14 entries only two plots were transplanted, owing to the ravages of ducks amongst the seeds beds. At Bush Lot, the plots made good progress; they were rogued and weeded throughout. Water supplies were well maintained. Preliminary visits were paid to the farmers who entered for the miscellaneous farm competition on the East Bank, Berbice River.

At Pln. Blairmont a demonstration block of about 6 acres was planted with budded grapefruit trees. The plantation is laid out on the equilateral triangle system the distance apart being 30 feet.

In the New Amsterdam back dam a row of 100 budded citrus was planted by Mayor and Town Council.

The collection of sweet potatoes on the Prison Farm was increased by five varieties from Essequibo. There are now twelve varieties being extended for future experimentation. On the same farm the sweet potato manurial trial has invoked considerable interest. Reaping will be carried out early in December.

During September 900 lime seedlings were imported from the North West District and distributed at cost of freight only. Interest in citrus growing is spreading and large orders for budded plants were booked.

Together with the Chemist Ecologist, the Superintendent paid a visit to the Berbice River when eight estates were inspected between Coomacka and Osterleck. At Maria Henrietta Mission a farmers' meeting was held when an interesting discussion took place. A full report was submitted.

On Pln. Blairmont 10 composite samples of typical soils were taken and submitted for analysis in September.

At the 8 Co-operative Credit Banks monthly meetings were held by the Superintendent and Instructor, Corentyne.

In August the Acting Director held meetings of farmers at the following centres: Bush Lot, W. C. Berbice; Mara, New Forest, Rosehall Village and 63, and imported vegetable growing was urged.

Rice for export was graded throughtout the period and a resumé of exports is given below:

	No. 2	No. 3	Broken	Totals
July	450	350	200	... 1,000
August	1,703	...	...	... 1,703
September	2,514	...	...	... 2,514
	4,667	350	200	5,217

District work has gone on as usual and instruction given freely by all officers. Meetings were held throughout the district when Pure Line seed farms were discussed and explained. Large numbers of prospective seed farmers were noted. Excellent weather conditions prevailed for the rice crop and prospects for good returns were excellent.

H. MACLUSKIE,
Agricultural Superintendent,
Berbice.

ESSEQUIBO.

The Experiment Station, Henrietta.—The Manurial and Varietal Experiments were planted during the early part of July. Six different varieties of paddy are being tested in the varietal trial, Essequibo Blue Stick variety was planted for the manurial trial.

The Assistant Superintendent carried out the work of planting these two experiments. Estate proprietors are particularly interested in the manurial trial, as the need for fertilizers on old land is becoming apparent especially where two crops are grown each year.

Minor Crops.—The sweet potato slips from the Barbados varieties are being multiplied on the sand reef for distribution in the District. Provision farmers, at present, do not go in for sweet potato cultivation on any organised lines. It is hoped to encourage the growing of this crop, however, with a more marketable variety of potato.

The Bush Lot Settlement.—Work on the Settlement has been chiefly concerned with the planting up of the paddy lots and provision farms. When the paddy came into ear, instruction was given in "roguing" to eliminate undesirable types.

Instruction has also been given to the settlers in onion cultivation, in preparation for the setting of nurseries when the onion seed arrives.

Planting material is being raised on the Demonstration Farm, Special White Corn, Yams, and Black Eye Peas being raised. This material will be available for the next planting season.

Co-operative Credit Societies.—Monthly meetings of the 3 Banks in the Essequibo District have been held. Special meetings of Committees have been arranged to consider the question of outstanding loans, and steps to be taken for their recovery.

General.—Work in the District has again been almost entirely confined to the distribution of Pure Line Seed Paddy. Blue Stick being the variety. This work has again occupied the bulk of the travelling time of the Superintendent of Agriculture, and the Assistant Superintendent.

Private Seed Farms, growing pure line seed, were instituted in every part of the District and Wakenaam Island. These farms have been inspected regularly once per month, and in many cases twice. These regular inspections have been the means of maintaining the farmers interest, and thus ensuring that the seed plots obtained proper attention.

Demonstations in "roguing" have been given to all farmers growing pure seed. Over 200 Private Seed Farmers have been established altogether. From these the seed supply of the District will be obtained.

Competitions.—Entries for the competition have much improved on last year's figures. All these entries have been inspected, both on the coast and Wakenaam Island. The competition is a very keen one and final judging cannot be completed until the yields have been ascertained.

Provision Farms.—During September an investigation of provision farms was carried out with special reference to the production of plantains. Figures showing the total number of bunches expected during the later months of the year have been collected for the British Guiana Producers' Association.

The production of plantains in the District is large and likely to exceed local demand. It is hoped therefore, that the British Guiana Producers' Association will be of some assistance in the marketing of this crop.

Garden Crops.—280 ozs. of onion seed were ordered for farmers in the District. The Assistant Superintendent has paid visits to all those ordering seed and practical instruction in the preparation of nurseries and the setting of the seed has been given. Circulars containing instructions have also been distributed to all those ordering the seed.

It is intended to carry out periodic visits to all onion growers on the same lines as those arranged for the seed paddy growers.

Coconuts—A trial in coconut manuring was laid out by the Chemist Ecologist on one estate in the District.

Grading Rice—Since the grading office was opened at Anna Regina the volume of business has increased. Miller-Exporters are nearly all shipping, direct to the steamer, from the coast at present. This work has increased the travelling considerably.

Anna Regina Estates.—The running of the Anna Regina Estates and the Bush Lot Settlement by the Superintendent of Agriculture has continued.

UNEMPLOYMENT RELIEF WORKS.

The work on the Anna Regina Extension Scheme was commenced shortly after His Excellency the Governor's visit to Anna Regina in July, with the above funds.

The work taken in hand was as follows:—

1. Improvements to irrigation and drainage, and the clearing of all abandoned trenches.
2. The building of check sluices to improve irrigation.
3. The clearing of additional land for pasture.
4. The clearing of land for provision farming.
5. Wiring additional pasture land,
6. Breaking in land for paddy cultivation.

The work has been under the supervision of the Superintendent of Agriculture.

A large labour force has been employed, and this has needed a great deal of supervision and organisation which has taken up practically the whole time of the Officer in charge. The accounting work has also been greatly increased.

All the land now being taken in for cultivation will be allocated to tenants for the next planting season.

On all works carried out, an average of 400 men have been employed each week from Anna Regina Estates and the Villages in the District.

This work has been of great assistance to the labour, for whom there had been no work of any kind for some considerable period. Since the work was commenced the following has been completed :—

> 174 beds have been broken down for paddy cultivation on Anna Regina and Henrietta estate sections.
>
> 180 acres have been underbushed for ground provision cultivation.

Drainage and irrigation works have been commenced on 3 estate sections including the building of weirs and check sluices.

Work has been commenced on underbushing and improving the pasturage areas, and also of wiring in new areas. This work is being carried out on all the estate sections, Anna Regina, A and B, Henrietta and Richmond North and South sections. This work will be suspended temporarily during the paddy harvest when the labour supply is small.

The applications for land at Anna Regina exceed the available acreage considerably.

A. deK. FRAMPTON,
Agricultural Superintendent.
Essequibo.

NORTH WEST DISTRICT.

Experiment Station, Hosororo.—His Excellency the Governor, accompanied by the Ag. Director of Agriculture, visited the Station at Hosororo on July 2.

His Excellency inspected the citrus cultivation and nurseries and poison plants area, and a portion of the pegasse flats.

It was decided that careful experiments should be carried out on a wide basis with various green cover crops with a view to deciding whether, and at what cost, worn out pegasse can be brought back to fertility in a reasonable space of time.

Work on these lines has been started and nurseries have been extended whilst the work of budding limes on sour orange stock has been pushed on as fast as stock was available.

At the end of September, there were 39,000 lime seeds sown and 6,530 sour orange. The sour orange seeds are not available as the fruit has not yet ripened. There were on hand, at the end of September, 30 budded grape-fruit, and 30 budded limes whilst the following were distributed from July-September : Budded limes—1,534 plants, exclusive of 42 to Wauna, and 18 budded grape-fruit.

With respect to lime seedlings, there were at the end of September 26,000 seedlings ready for the field and available for free distribution.

Poison plants.—A number of cuttings died in the new areas, due possibly to unfavourable weather and to the fact that, for economical reasons, the cuttings were made smaller and dried out. These have been 'supplied.'

Wauna Station.—The Haiari planted in February, 1931, is coming on, with the exception of those in the unshaded area which died and have since been 'supplied'. The Yarroconalli has to be replanted.

During July, 4 acres were planted with budded citrus. These have made a good start—the limes especially.

The Wynne grass (*Melinis minutiflora*) continues to make rampant growth.

A nursery of coconut palms has been made and 250 nuts sown during September.

Coffee.—In spite of the depressed state of the market a number of farms are up to standard. With the exception of those trees from which the last crop had not been picked and the flower cushions consequently damaged, the trees are yielding well, but harvesting will not take place until late in November. Some of the smaller farmers have allowed their coffee areas to be overrun with 'bush'. Very little *Sclerotium coffeicolum* (Stahel) fungus is to be noticed and the trees on the whole look well.

Coconuts.—The Moruca District contains some very fine varieties of coconuts especially Santa Rosa.

Cacao.—Some of the farmers who have taken up the lands on the Hosororo hill express their intention of planting cacao. At the end of September the area under cacao was 94 acres, of which about 15 are fruiting. There is no reason why the local demand for cacao should not be satisfied by the North West farmers. No witch broom has been observed in any part of the North West, in marked contrast to other places of the Colony. In the Arakaka District there are one or two acres of cacao of good variety.

Citrus.—On the Arukamai Hills there are 7 acres of budded citrus and other fruit trees, the budded citrus were imported, a few years ago, from the world famed St. Mary's nurseries.

The Arakamai District holds out possibilities and already attention has been drawn to these areas and land has been taken up.

Messrs. Garnett & Coy. Ltd. have planted about 14 acres in budded limes and one farmer 10 acres, and yet another farmer has established 10 acres in lime seedlings, whilst one grant holder has about 200 budded oranges on stocks grown by the owner and budded by one of the men from the station.

Considerable interest has been aroused in citrus cultivation and everyone is keen on budded plants.

Limes are fruiting heavily—on the other hand a number of sour orange and seedling grape-fruit are bearing poorly this year and in some instances are not holding their fruit.

Agricultural Investigations.—Work in connexion with cover crops, the incidence of Sclerotium fungus and Mosaic disease of tobacco has been carried out.

Agricultural Education and Extension.—A site has been selected for a school garden at the Hosororo Convent and it is expected shortly to start a school garden under the direct supervision of the Agricultural Superintendent.

Co-operative Work.—The farmers connected with the free survey of certain blocks of land are clearing these areas on a co-operative basis. The co-operative marketing of farmers' produce has also been started and it is hoped that the effort thus made will eventually lead to co-operation on a larger scale.

Competitions.—The competition for the best kept miscellaneous farm will be finally judged early in November.

E. BECKETT,
Agricultural Superintendent,
North West District.

NOTES.

Yams.—Probably introduced to the West Indies from tropical Asia very many years ago, Yams form an important article of food in British Guiana and the West Indies.

The plant has twining annual stems which arise from tubers—it is these tubers which are eaten and are known as "Yams". There are numerous varieties, but the best known here are the "Barbados Yam," the "White Yam" "Cush Cush Yam," the "Buck Yam," etc. The variety of the Buck Yam is a reddish purple and is much sought after, although it is not now so much in prominence as it used to be. Growers should make efforts to obtain this variety as it is in demand in the local market and fetches a food price.

The "wild" yam with round and partly thorny stems, generally found growing around the clearings of the Aboriginal Indians, is of a yellowish colour, and made very palatable when it is pounded or "mashed" and served hot. The tubers of "Cush Cush" although small are of a good flavour.

The yam is said to be more nutritious than the potato and, as large yields are obtained when they are cultivated on suitable soils, ought to be more frequently seen at our table than is the case at present. More attention might be paid, with advantage, to the cultivation of this crop.

Soil.—A rich, friable, sandy loam or a rich pegass soil, produce large crops of good yams. The red lateritic hills grow yams of an excellent flavour as do some of the sandy hills. The yields on the hills are usually not so heavy as those obtained from well-drained and fertile virgin pegass lands.

Good drainage is an absolute necessity—especially is this the case when grown on pegass areas.

Cultivation.—Yams are usually propagated by "eyes," like potatoes—in some cases the small axillary tubers, which form on the main stem, are utilised for planting. Generally 5 bags of yams will furnish sufficient tubers to plant one acre—the large tubers being cut into pieces, each piece having at least one "eye."

Small mounds or hillocks at the most 12″ high are made, the distance being 3′ x 3′ or 4′ x 4′.

The land must be friable and in a good state of tilth and the cultivation must be kept free from weeds during growth—it is necessary to mould up the "hillocks," or mounds occasionally.

In rich pegass, crops of corn or maise are first taken off, and a yam crop planted, the corn stems often being left for the vines to cling on.

The right time for planting is during April and May, if large crops are to be obtained, but often it is a more paying proposition to plant out of season and obtain small crops, when there is a dearth of yams and very high prices are ruling.

Yields.—In the North Western District very high yields are obtained on virgin pegass—as much as 30,000 lbs. to the acre have been obtained. The usual return, however, on pegass lands is 10-15,000 lbs. per acre and on the hills 10-12,000 lbs.

Where yams are staked to allow the yam vines to climb, it has been proved by experiment at the Hosororo Station in the North West, that the yields are higher than on unstaked areas. Reaping is undertaken when the vines begin to dry; in many varieties they should be reaped 11 months after planting, though there are some varieties which yield returns in 9 months or less.

Costings.—The actual figures of the cost per acre at the Hosororo Station, on somewhat stiff and worn out pegass, were as under :—

Weeding ...	$ 5.28	per acre
Making mounds and planting ...	15.20	„ „
Weeding just before digging to facilitate reaping ...	2.71	„ „
Reaping, transporting and bagging ...	24.24	„ „
Total	$ 47.43	„ „

With a yield of 18,000 lbs. per acre and with a market offering only 1 cent per lb. and even reckoning the cost of the yams for planting purposes in the first planting, there is a wide margin for profit.

On the worn out pegass at Hosororo the yield was at the rate of 9,481 lbs. per acre and for the staked area, 11,454 lbs. Yams are frequently sold at $3.00 per bag of 180 lbs.

Recipes.—The following recipes for cooking and preparing yams were issued by the Imperial Department of Agriculture in 1902, so that this nutritious food might be presented in the most attractive forms. The recipes here quoted were prepared by Mrs. J. R. Bovell of Barbados.

RECIPES.

Roasted Yam.—Lay a yam before the grate of a stove or in the oven, turning it occasionally until cooked. Scrape off the outer skin, cut into pieces or mash with butter and serve hot.

Baked Yam.—Pare a yam, put it in the oven and bake until soft, take it out of the skin, mash with butter, put it back into skin, cut into pieces and served hot.

Boiled Yam.—Pare a yam, put it into boiling water, cook until tender, serve whole.

Yam Chips.—Pare and boil a yam until tender. Cut in chips, fry in boiling lard and serve hot.

Yam Rice.—Pare and boil a yam until tender, press through a colander lightly every few seconds, to cause the yam to fall off in short grains like rice, serve very hot.

Yam Rissoles.—Pare, boil and mash a yam, add pepper and salt and, if liked, a little minced parsley. Shape into rissoles, cover with egg and bread crumbs and fry until a light brown.

Yam border.—Pare, boil and mash a fair-sized yam, about 2 lbs. in weight, add to it two tablespoonfuls butter, half a cup of boiling milk, one tablespoonful salt, the yolks of two eggs well-beaten ; beat the mixture until very light. Butter a border mould, pack the yam in it, let it stand for 8 minutes. Beat the whites of the eggs to a froth, add salt, turn out yam, cover with the whites and put in an oven to brown. Take from oven and fill the centre with meat or fresh fish heated in a sauce.

Yam au choux.—One pound boiled yam, one boiled cabbage, two tablespoonfuls cream, one ounce butter, with salt and pepper to taste. Rub the yam and cabbage through a wire sieve, mix together with butter, cream and seasoning. Pile upon a dish and serve with fried croutons of bread around. Serve very hot.

Porcupine Yam.—Two pounds yam, boil and mash with one egg and salt to taste. Shape and roll in beaten egg and vermicelli. Serve hot with parsley.

Yam Fritters.—Pare and boil half a pound of yam until soft, beat lightly with a fork. Beat the yolks of four and the whites of three eggs, add two tablespoonfuls of cream, two tablespoonfuls of wine, one dessert spoonful of lemon juice and half a teaspoonful grated nutmeg ; beat all together until extremely light. Put plenty of lard into a frying pan and drop a tablespoonful of the batter at a time into it, and fry the fritters a nice brown ; serve with wine sauce served separately, or only sprinkle powdered sugar over them.

Yam Pudding.—Half a pound of yam, 2 eggs, one lemon, two ounces butter, two ounces sugar. Pare and boil the yam and rub it through a sieve while hot. Beat the butter and the yam together and allow the whole to cool. Break the eggs and separate the yolks from the whites. Beat the yokes until light, add sugar, juice of lemon, the grated rind and the yam. Whisk the whites to a stiff froth and stir lightly in before baking. Put in a well buttered dish and bake in a brisk oven for twenty minutes.

Yams en Brun.—Cut up one pound of yam already boiled and fry a light brown, sprinkle thickly with chopped parsley and eschallot or mushroom, pepper, salt and lime juice, and serve very hot.—E. BECKETT.

Agricultural Machinery.—In August 1925, the Governor-in-Council exempted from duty certain ploughs, cultivators and subsoilers manufactured in the United States on the ground that machinery of a like nature was not procurable in the British Empire. Under this Order of the Governor-in-Council application was recently made for the exemption from import duty of certain "caterpillar" disc ploughs, which were being manufactured in the United States of America, which were claimed to be suited to the conditions obtaining in British Guiana, and which efforts were being made to place on the local market.

As an outcome of this application, enquiries were instituted through the Federation of British Industries and the Empire Marketing Board, to ascertain whether it were possible to procure agricultural caterpillar tractors and ploughs in the United Kingdom of a similar type to those manufactured in the United States. The most favourable specifications have been obtained from Messrs. Ransomes, Simms and Jeffries, Ltd., Ipswich, England. This firm manufactures the "Hussar" and "Dragoon" disc ploughs which are claimed to be superior to the American plough offered in competition. In addition, the firm makes a special disc plough, called the "Shugadisc", for work in sugar fields, of which, it is stated, there is no American counterpart.

Messrs. Ransomes, Simms and Jeffries have forwarded to Government catalogues and price lists which will be readily offered for inspection to persons interested.

Opportunity has been taken to give publicity to this matter since it is conceived that the production of these types of implements by a firm within the Empire is worthy of very careful investigation by local agricultural and commercial interests, more especially when the present rate of exchange is taken into account.—H.D.H.

The Report (C.A.C. 85) of Mr. R. E. Montgomery, M.R.C.V.S., Advisor on Animal Health to the Secretary of State for the Colonies, on a visit to the West Indies, British Guiana and Bermuda, arrived in this Colony in October last.

The matter dealt with in the report falls under the following heads :
(a) Numbers of stock, ownership and objectives ; (b) Pastures, foodstuffs and water ; (c) Breeding and management ; (d) the Diseases situation ; (e) Present economic uses of animals and animal products ; (f) The development of markets ; (g) Administration of animal health.

While in England the Director had the opportunity of discussing further, with Mr. Montgomery, the livestock problems of this Colony.

REVIEW.

THE USE OF FERTILISERS IN TROPICAL AND SUB-TROPICAL AGRICULTURE.

By A. Jacob, PH. D and V. Coyle, M.Sc. (*Ernest Benn Ltd.*, London). 272 pp. Price 10/6.

The authors in this book have attempted to show that manuring can be of great value in cheapening production by improving quality and by increasing yields per unit of area cultivated. The book is divided into two parts. Part I contains terse chapters upon the functions of fertiliser constituents in the plant, the composition of tropical soils, the different classes of fertilisers and the methods of mixing, the method and time of application of fertilisers and the general conduct of manurial experiments in plantations.

Part II describes the results of manurial trials and suggests the composition of standard fertilisers for tropical crops.

One cannot commend the chapter upon the design of manurial experiments to the consideration of planters engaged upon the intensive cultivation of the major tropical crops. The comparison of unduplicated plots offers them little assistance with their problems. They would be well advised to seek the co-operation and advice of the specialist before embarking upon fertiliser experiments. The need for applications of lime to tropical soils receives scant notice although it is probable that a number of the crop failures reported are due to a lack of this important constituent.

In Part II a large number of tropical crops are considered. It is confidently assumed that a standard fertiliser formula for each crop can be evolved irrespective of the type of soil encountered. The implication that the results of plant ash analyses confirm the statement that a certain crop requires a definite mixture of fertilisers is without foundation.

The book, which is well printed, should be of interest to all people engaged in tropical crop production.—R. R. FOLLETT-SMITH.

DEPARTMENTAL NEWS.

Mr. J. A. V. Bourne, Accountant, returned to the Colony from leave on October 30 and resumed his duties on November 16. Mr. Bourne was on four months' vacational leave which was spent in Barbados and the United States of America.

Mr. E. B. Martyn, Botanist and Mycologist and Superintendent of the Botanic Gardens, returned to the Colony and resumed his duties on November 26. Mr. Martyn was on long leave and spent his holiday in England.

Professor the Hon. J. S. Dash returned from leave on Sunday, November 29. The Director travelled *via* the Spanish Main, Curacao, Haiti and New York on his way to Canada, and left Canada in July to attend the Conference of Colonial Directors of Agriculture and the Imperial Sugar Cane Research Conference.

The Director also took charge of the Colony's stand at the Toronto Exhibition held in August and September.

On his way back to British Guiana the Director passed through the British West Indies and was able to see the developments which had taken place within recent years.

Mr. F. Burnett, Acting Director, went on tour in the Essequibo District, and there inspected the work being done in connection with the Land Settlement scheme and unemployment relief measures. Tours of inspection were also made on the East and West Coasts, Demerara.

Mr. R. R. Follett-Smith visited the sub-station "Cecilia." Visits were also made to Plns. Blairmont, Versailles and La Bonne Intention in connection with investigations on cane soils. Analyses of cane samples at the Sugar Experiment Station, Sophia, were made during the period under review.

Mr. C. H. B. Williams, Sugar Cane Agronomist, has been engaged in reaping variety experiments with sugar-cane at Plantations Uitvlugt, Diamond, Lusignan, Blairmont and Port Mourant. He has also established a new variety trial at Plantation Non Pareil. At Sophia three variety, one large manurial, one spacing and two drainage trials have been reaped.

Mr. H. W. Hewitt, Agricultural Instructor, Department of Agriculture, Surinam, visited the Colony during November to study the method and organisation which this Department has evolved for the grading of rice for export. It is understood that the Surinam Government is making arrangements for the institu- of a similar system of grading and that Mr. Hewitt will be placed in charge of the rice grading operations.

The Chamber of Commerce has appointed a sub-committee, consisting of of Messrs. E. M. Walcott, H. B. Gajraj, A. S. MacGillivray, F. H. Martin-Sperry and F. Burnett, to consider recommendations with regard to certain charges in the Rice Grading Regulations.

The Secretary of State has approved of the appointment of Mr. D. D. Haynes as a District Agricultural Instructor. Mr. Haynes has been for some years attached to this Department as a part-time officer.

The machinery to be used in the erection of the rice mill at Anna Regina, funds for which have been provided by the Colonial Development Fund has arrived in the Colony. It is hoped that it will be possible to erect this early enough to be used for the 1932 Spring crop.

ERRATA

In Vol. IV. No. 2. p. 71, table headed "Comparative Results," please read:

Variety	*Age, Days*
79	156
Blue Stick	156
Demerara Creole	156
H7	156
76	156
75	156
A 16-34	178
C 14-31	178
Lady Wright	156
Mexican Edith	156
Carolina	156
Blue Rose	156

PLANT AND SEED IMPORTATION.

THE FOLLOWING ARE RECENT INTRODUCTIONS BY THE DEPARTMENT OF AGRICULTURE.

Description	Quantity	Whence Received
Ornamental.		
Sapindus inaequalis (Soapberry Tree)	1 Plant	Agricultural Department, Dominica
Congea tomentosa	1 ,,	do.
Acacia Sphaerocephala	1 ,,	do.
Dombeya punctata	1 ,,	do.
Lagerstroemla floe-reginae	1 ,,	do.
Spiraea Reevsiana	1 ,,	do.
Crossandra undulaefolia	1 ,,	do.
Economic.		
Sweet Potatoes (Black Rock)	50 slips	Agricultural Department, Barbados
,, ,, (Red Nut)	50 ,,	do.
,, ,, (Six Weeks)	50 ,,	do.
,, ,, (Carolina Lea)	50 ,,	do.
Piper nigrum	12 plants	Royal Botanic Gardens, Kew
,, ,, var Balamcotta	1 plant	do.
Eugenia Jambolana	1 ,,	Agricultural Department, Dominica
Psidium Guava	1 ,,	do.
Nephelium Litchi	1 ,,	do.
Budwood		
Navel Orange	600 buds	Agricultural Department, Trinidad
Duncan	300 ,,	do.
Washington Navel	250 ,,	Agricultural Department, Dominica
Marsh Grapefruit	250 ,,	do.

EXPORTS OF AGRICULTURAL AND FOREST PRODUCTS.

Below will be found a list of the Agricultural and Forest Products of the Colony exported for the first nine months during 1931.

The corresponding figures for the same period during previous years and the average for the thirteen years prior to that are added for convenience of comparison.

Product		*Average 1916-28*	*1929*	*1930*	*1931*
Sugar	tons	58,094	49,947	66,343	63,883
Rum	proof gallons	1,466,605	891,685	625,661	656,888
Molasses	gallons	433,760	1,979,394	2,293,268	4,819,894
Molascuit	tons	891	1,083	350	20
Rice	tons	6,421	9,311	16,651	16,845
Coconuts	thousands	1,350	435	337	962
Coconut Oil	gallons	16,234	13,300	16,670	16,203
Copra	cwts.	9,300	58,769	32,905	27,620
Coffee	cwts.	4,501	8,049	1,198	5,272
Lime Juice Concentrated	gallons	5,178	10,275	7,942	7,694
Essential Oil of Limes	gallons	230	645	434	438
Rubber	cwts.	96	15	46	50
Balata	cwts.	4,554	2,293	2,585	3,139
Gums	lbs.	1,705	None	787	238
Firewood—Wallaba, etc.	tons	5,913	7,192	8,413	8,376
Charcoal	bags	33,077	37,612	39,603	44,851
Railway sleepers	No.	12,632	10,721	3,375	2,275
Shingles	thousands	1,469	1,799	1,208	716
Lumber	ft.	142,666	82,726	99,622	196,531
Timber	cu. ft.	107,486	262,267	142.370	135,527
Cattle	Head	297	466	1,305	142
Hides	No.	5,408	5,133	5,434	2,675
Pigs	No.	314	271	672	283
Sheep	No.	23	None	4	15

CURRENT PRICES OF COLONIAL PRODUCE.

From The Commercial Review, Journal of the Georgetown Chamber of Commerce, Vol. XV, No. 5, Monday 30th November, 1931.

SUGAR.

Per 100 lbs. net   3 lbs. per Bag allowed for tare

Dark Crystals for Local Consumption..................$2.80

Yellow Crystals do. do. $3.50

White Crystals...$4.25 to $4.35

Molasses Sugar...none offering

RUM.

Imperial Gallon.   Cask included.

Coloured, in Puncheons—40 to 42 O.P...(for export).....60c. Hhds. 65c. Barrels 70c.

White, in Hogsheads—10 to 45 O.P....(for local consumption)............48 to 55c.

MOLASSES.

Per Imperial Gallon.   Cask included.

Yellow (firsts)...} None Offering
Yellow (seconds)...}
Dark...}

RICE.

Rice............per Bag of 180 lbs. gross, $2.75 to $4.00 as to quality.

Paddy..........per Bag of 155 lbs. gross, $1.12 to $1.75 as to quality. Reaping.

GENERAL.

Gold, Raw,...per oz. $18 to $20.

Diamonds,—pro rata as per quality.......................average per carat $13 to $14.

Timber, Gr. Heart, (Lower grade measurements)...72c. to 96c. per c. ft.,
for export $1.00 to $1.20 per c. ft

Do. Railroad Sleepers—(Mora)..$1.68 each.

Greenheart Lumber...$110 per 1,000 feet.

Crabwood Lumber.......................................$60 to $75 per 1,000 feet.

Shingles, Wallaba, 4 x 20 and 5 x 22 inches,......................$4.00 to $5.00 per M.

Charcoal, Capped for shipment...60c. to 80c. per Bag.

Firewood...$2.16 to $2.50 per ton

Coconuts ....Selects, $12.00, culls......$8.00 M .....$2.10 per 100 lbs. prime Copra.

Balata.........................Venezuelan, none. Local Sheet...36 to 38 cts. per lb.

Cocoa...14c. " "

Coffee...6c. " "

N.B.—Duty payable on value at time of Importation and at Rate of Exchange on day of arrival.

METEOROLOGICAL DATA—JULY—SEPTEMBER, 1931.

Recording Stations & Months.	Rain-fall. Total Inches.	NUMBER OF DAYS OF RAIN: Under ·10 Inch	·10 to ·50 Inch	·50 to 1.00 Inch	1.00 Inch to 2.00 Inches	Above 2.00 Inches	Total days.	Evaporation. Inches	Air Temperature and Humidity: Air Temp. Maximum.	Minimum.	Mean	Humidity. Mean
Botanic Gardens.												
July ...	12·42	3	11	8	3	...	25	3·95	85·5	75·1	80·3	82·9
August ...	6·44	5	9	4	1	...	19	5·76	86·7	75·8	81·2	81·3
September ...	4·43	4	5	1		1	11	5·96	87·6	76·7	82·1	80·5
Totals	23·29	12	25	13	4	1	55	15·67				
Means.	...	...	...	...	...	...	...	...	86·6	75·9	81·2	81·6
Berbice Gardens.												
July ...	11·86	4	9	6	3	1	23	...	89·0	74·9	81·9	80·0
August .	3·49	5	2	2	1	...	10	...	90·7	75·9	83·3	77·5
September ...	4·57	1	7	1	1	...	10	...	90·7	76·5	83·6	77·3
Totals	19·92	10	18	9	5	1	43	...				
Means.	..	...	.	...	...	...	...	...	90·1	75.8	82·9	78·3
Onderneeming.												
July ..	13·84	..	12	6	5	...	23	...	87·8	74·1	80·9	84·7
August ..	6.41	1	6	6	...	...	13	...	89·5	73·7	81·6	85·3
September ...	4·29	...	5	4	...	...	9	...	90.1	73·5	81·8	85·7
Totals	24·54	1	23	16	5	...	45	...				
Means.	...	...	...	...	...	...	...	...	89·1	78 8	81·4	85·2
Morawhanna, N.W.D.												
July ...	13·34	7	11	1	7	...	26	...	...	...	...	...
August ...	5·16	5	12	1	1	...	19	...	...	...	...	...
September ...	7·43	11	9	4	1	...	25	...	...	...	...	...
Totals	25·93	23	32	6	9	...	70	...	...	...	..	...

INDEX TO VOL. IV.

1931

A

B

C

F

G

L

M

R

S

Page

T

W